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WORLD PETROLEUM

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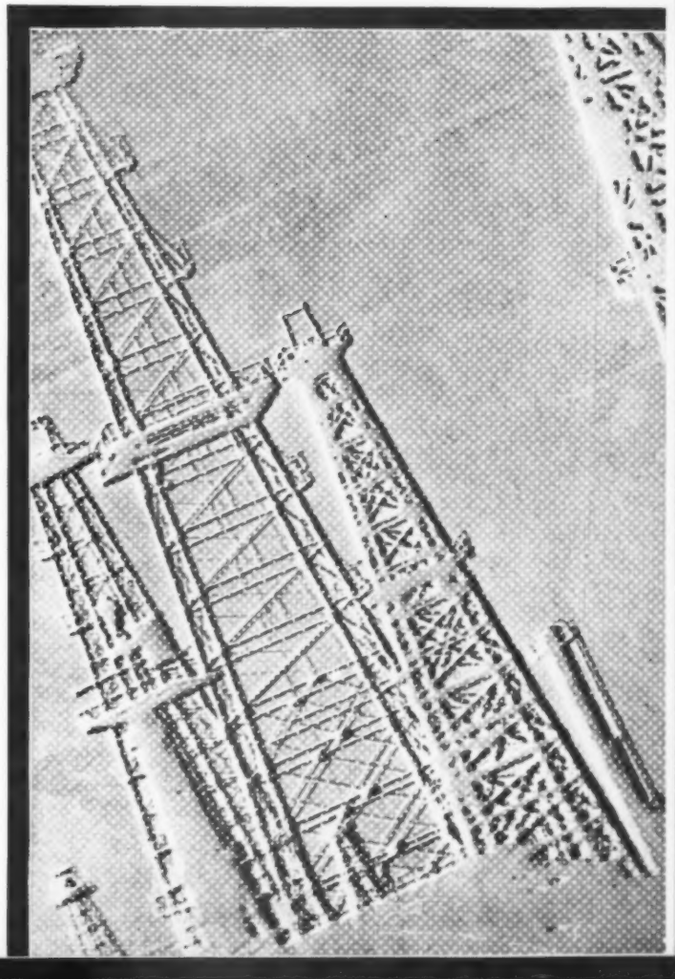

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1935

WORLD PETROLEUM

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C. MCGARRITY,
Circulation Manager

Subscribed to and sworn before me on this 26th day of April, 1935.

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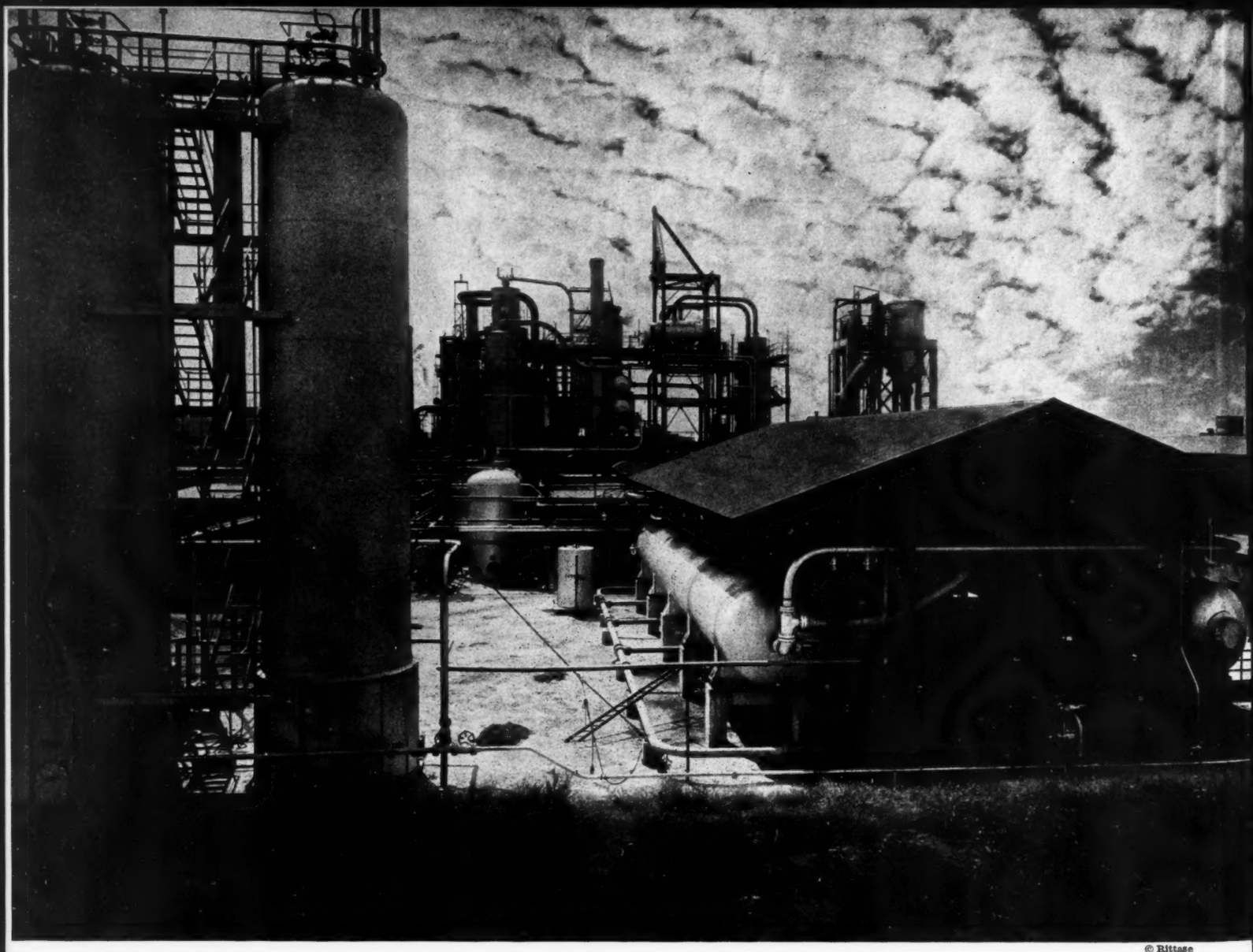

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A striking view of Socony-Vacuum's Paulsboro, N. J. refinery where the new Clearsol lubricating oil is produced by the Duo-Sol process.

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WORLD PETROLEUM

An Issue Emerging

Out of the welter of discussion and the confusion of thought arising from the legislation enacted at Washington in the name of the New Deal a definite alignment of opinion is beginning to emerge. The issue—and from present indications it is the issue on which the next presidential election in the United States will be fought—is whether the role of the federal government in relation to business shall be that of the arbiter who sees to it that the game is played under fair rules or whether government itself is to direct business and to an increasing degree participate directly in its management.

Whatever may have been the original intention of the President a survey of pending and proposed legislation at Washington leaves no doubt that the trend is decidedly toward a direct participation of the government in the control and operation of what has been regarded heretofore in the United States as private business. Whether the label to be attached to this program be socialism, collectivism or fascism the facts are indicated by the terms of banking, labor and holding company bills now before Congress, by the Guffey coal bill, by the reported program in relation to petroleum and by numerous other proposals now in the legislative mill.

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Changing the Code System

If the so-called recovery legislation enacted in the United States in 1933 contained a vital and valuable idea it was that of permitting members of an industry to act together under federal supervision to eliminate abuses and wasteful practices. In the actual administration of codes, however, the part played by industry has been more and more restricted and the authority exercised by governmental bureaus has been steadily extended. In the bill now before Congress which provides for a two year extension of the NIRA the avowed purpose of the original legislation apparently is pushed further into the background. Power is centered still more largely in appointive officers while the part allotted to the representatives of industry, even in a consultative capacity, is made more tenuous than before.

Here unquestionably is the weak point in all projects for the partnership of government and business. Government inevitably becomes not merely the major partner but the one in absolute control. Its share in the joint enterprise is necessarily administered through bureaucrats who have nothing at stake but their political positions and whose tendency naturally is to absorb more and more power and to impose their own theories and ideas upon those who are brought into association with them. Where force rules freedom disappears.

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Cooperation vs. Coercion

In actual operation the codes that have been most successful are those that have adhered to the original theory of the Recovery Act. Attempts to fix prices or to impose arbitrary regulations in disregard of varying local conditions have failed. In the oil industry such improvement as has been accomplished has come mainly from voluntary action. Recent progress toward greater stability in the marketing branch of the industry has resulted from a realistic appraisal of existing conditions and the reconcilement of conflicting interests on a basis of fairness to all concerned. Such methods are succeeding where threats of prosecution and attempts at coercion have proved dismal failures.

Business cannot flourish in a strait-jacket. To prosper it must maintain its flexibility and the power to adjust itself to changing conditions. This it cannot do if its every act is to be dictated by official overlords. These are considerations that should be kept in mind in legislation extending the life of the NRA and in the rewriting of existing codes.

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An Example from France

With no purpose to act unjustly toward any interest the attempt to regulate business operations by legislation may still produce unfortunate results. This particular point is brought out clearly in the analysis of the oil trade situation in France which our deeply lamented Paris correspondent has contributed to this issue. Mr. Beatty cannot be accused of prejudice against the governmental authorities. In fact he pays a high but deserved tribute to the operation of the Office National des Combustibles Liquides under the direction of Colonel Pineau. As he shows the provision of import licenses for refined products was made in the interest of fairness but it

has now worked out most unfairly for companies that have invested great sums in providing refining facilities in France.

As matters stand at present the entire internal consumption of petroleum products in France could be supplied through utilization of outstanding import licenses. Similarly it could all be supplied by the refineries constructed within the country during the past few years. Actually neither condition prevails. The trade is divided between the importers and the refiners. Whenever prices rise to a point that promises a profit the speculative holder of an import license is able to inject himself into the situation, reap a quick profit and retire when the confusion which he has produced puts an end to all profit.

As Mr. Beatty points out the correction of this situation offers many difficulties. Investors in storage facilities, by reason of the fact that they have made their investment in accordance with provisions of the law, cannot be subjected to confiscation. In fact no easy way out of the difficulty without some hardship upon one interest or another appears to present itself. About the only possible solution is to cancel import licenses that have remained unused and to fix the allowable imports on a three-year basis with a determined maximum tonnage. This is far from an ideal solution but it seems to be the one that is the most readily workable and that involves the minimum of loss.

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Libel Action

WORTHY of note is the encouraging demonstration that, in one country at least, it is not necessary to submit tamely to outrageous misrepresentation. British Controlled Oilfields, Ltd. recently performed a signal service for the oil industry by bringing into court the London publishers of "The Secret War" and securing a public retraction and withdrawal of charges affecting the company.

The particular issue involved was typical of the loose charges and sensation mongering statements in which the book abounds, being in effect an allegation that the company was a blind for the British government rather than a legitimate commercial enterprise and that its acquisitions of oil concessions in and about the Caribbean were made for the purpose of giving that government control of the approaches to the Panama Canal. The mere fact that a charge of this kind is on its face ridiculous to those who are well informed is no guarantee that it will not find believers among others who have no special knowledge of the subject and who are being fed systematically upon literature of this type. It is too much to expect that oil companies and individual members of the industry will go to the trouble of undertaking legal action against every slanderous statement published, but if an example is made now and then of glaring offenders it may lead to a more cautious attitude on the part of readers and publishers in accepting such statements if not on that of the sensational writers in making them.

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Petroleum Publicity

IN A recent address before the Oil Industries Club in London Mr. Adrian Corbett of the Asiatic Petroleum Company referred to the large number of sensational and fantastic books and stories having to do with the oil industry that have appeared from time to time. He pointed out the serious injury done by these misleading publications and the singular remissness of the industry in failing to make its operations better understood by the general public.

While Mr. Corbett illustrated his point with examples drawn from the situation in the United Kingdom with which his auditors were familiar his remarks should be carefully studied and considered by members of the petroleum industry everywhere because similar, or in some instances even more threatening, conditions confront the industry in all parts of the world. It is an international rather than a national problem.

Oil today is such an integral and indispensable part of industrial life, touching upon the employment, comfort and prosperity of practically all elements of the population, that both the need and the opportunity for a better understanding of this relationship is greater than ever before. Consumers should be made to understand that undue taxation and discriminatory legislation place a greater burden upon their shoulders than upon those who are endeavoring to gain a livelihood from the production and distribution of petroleum and its products.

For many years the only problem of the oil industry was to find petroleum and get it to the markets that clamored for steadily increasing quantities of its products. Today that situation is changed. The industry must meet attacks from competitors who are politically more vocal and active, from rapacious taxation, from economic theorists, political demagogues and professional rabble rousers. It must fight these assaults or go down under them. It can fight them successfully by winning the support of the great body of consumers whose battle it will be waging at the same time.

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Fields Series

NO GROUP of articles published in WORLD PETROLEUM has elicited more favorable comment than the series currently appearing which gives a comprehensive survey of individual oil fields. By bringing together complete data on these representative fields our readers are being provided both with current information and with reference material which they assure us that they find most valuable. Many of them have written to say that the usefulness of this series will increase as the papers grow in number and come to the point where they will cover the more important and distinctive fields in the United States and other countries.

Particular approval is expressed by a large number of those who have communicated with us of the fact that these articles deal not only with the geological features of the fields described but also with their economic importance, development cost, production technique and probable reserves. Thus they combine information that is of definite interest not only to technical men but to all those who are concerned in any way whatever with petroleum production. Each field has its particular problems and many of them have developed special methods of procedure. Thus the Central Michigan field, described in this issue, has been the proving ground for acid treatment, a feature that receives particular attention in the article for this very reason.

Special timeliness attaches to this series of articles because of the very keen interest that exists at the present time in the development of new sources of supply and the appraisal of available reserves. With expert opinion agreed upon the necessity of drilling at least 20,000 wells yearly to maintain supplies the significance of this phase of the subject is evident.

Not only in the United States but in every part of Europe, Asia and Africa the scientific search for new fields and exploratory tests looking to the extension of old ones is going on. In connection with this activity the record of accumulated experience in the development of existing fields is of definite interest and value.

Import Permits Disturb French Market

Mass of Licenses Held for Speculative Purposes Menaces Position of Domestic Refining Industry Built Up at Government's Behest.

By H. O. Beatty

PARIS, APRIL

THE DOMINATING question of the moment relates to the reform which it is generally recognized must be undertaken with respect to general import licenses. They are survivals of a past when the oil industry was controlled and governed by policies and views quite different from those which now fix its status. Their existence constitutes an element of conflict and confusion, one wholly inimical to healthy competition and one which magnifies difficulties, where it does not multiply them, in a field already sorely harassed. They mark a stage in the gradual development of the industry to its present form and testify to the trend of modern conceptions concerning great enterprises. But, with the changes and modifications which have taken place in very recent years, the measures that were formerly logical and necessary have lost their utility. They have indeed become a serious hindrance to rational development and a source of grave anxiety to the vast interests engaged in the oil industry of France.

While the evolution of the industry shows the same tendency that is observable the world over toward the encroachment of the state in the control and management of enterprises responding to general public needs, the government has esteemed it unwise to subject the oil industry to its full domination. It is a managed industry, but none the less private since the capital with which it is conducted is derived from private sources. The inclination to substitute the government for private interests in the conduct of commercial pursuits finds expression as far back as 1891, when a proposal was made to the Chamber of Deputies to suppress the liberty to engage therein. In 1902 this idea had already gained ground to the extent that the Chamber voted a law declaring the petroleum industry to be a state monopoly. The law failed, however, to secure the ratification of the Senate and was lost. Similar attempts were repeated in 1903, in 1909 and in 1914.

It was the acute shortage of stocks resulting from the extraordinary demands of the war which led to the first legislation from which the present situation has evolved. In order to avoid wastage, it was found essential to place the control and disposition of all petroleum products and supplies in the hands of a central administrative board charged with the responsibility both of importation and distribution. Such a board was created in March, 1918, by the institution of the "Commissariat aux Pétroles et aux Essences," whose first duty it was to supply the necessities of the military forces and then, within the limits of its stocks, to satisfy those of civilian activities. For the latter purpose, and by reason of its lack of material means, the Commissariat was obliged to appoint as its agents for distribution, a group of ten import concerns then established in business. This method of operation, which constituted in fact nothing less than a state monopoly of temporary duration, continued in force until 1921. In that year a new system was provisionally set up, introducing for the first time the régime of import licenses. Although this amounted to a renunciation of the idea of a monopoly, it nevertheless represented a first step in the restriction of the complete liberty of private enterprise.

The law of July 9, 1921, ratifying the decree of May 7 of the same year, may be considered the foundation stone of the system now in force. It established the principles which have inspired all subsequent legislation. The full expression of those principles is to be found in the two laws of January 10, 1925, and March 30, 1928, which are those upon which the oil industry of France now reposes and by which its operation and conduct are governed. There are other laws and decrees relating to the same subject matter and its details, but, for our purposes, we need not go beyond this basic legislation except to refer further on to the law of July 25, 1931, by which the government itself became interested in the commercial operations of the industry.

The law of January 10, 1925, provided that the wholesale importation of petroleum, as well as that of its products, could be effected only by virtue of a previous authorization delivered by the Minister of Commerce and Industry. Such authorizations could be obtained by any company or individual agreeing to submit to the prescribed conditions. Wholesale importations were defined to be either a single importation equal to or in excess of 1,000 kilos, or monthly importations equal to or in excess of 15,000 kilos.

IT IS with deep sorrow that the editors of WORLD PETROLEUM announce the death of their Paris correspondent, Mr. H. O. Beatty, which occurred without previous warning on April 14. The accompanying article dealing with one of the serious problems confronting the petroleum trade of France reached the editorial offices almost at the moment of his demise. It is an excellent example of the logical and fair minded treatment which Mr. Beatty gave to every subject illuminated by his pen. It is through the constructive work of men such as he that the conflicting interests of private capital and state policy are reconciled and brought into workable union. In his passing not only WORLD PETROLEUM but the French oil industry as a whole have suffered a great and irreparable loss.

The most important of the conditions to which the importer was obliged to subscribe was that referring to the establishment of reserve stocks. The remembrance of apprehension and concern experienced as the result of the shortage of stocks during the war made it imperative to provide a large reserve available at any moment in case of exceptional need. Importers were required, therefore, to set apart for this purpose a certain percentage of their shipments. With respect to those already established in business, they were required to hold in reserve an amount equal to 25 percent of the products delivered by them during the preceding twelve months for sale on the market. With respect to those just entering the business, they were compelled to set aside one-quarter of their monthly importations as received. Obviously the constitution of these reserve supplies necessitated the construction of reservoirs for storage purposes, to which reference will be made below, since it constitutes one of the difficult elements in our problem.

Other conditions, complementary in character, were imposed on the importer, such, for example, as the duty to make certain declarations and returns to the Ministry of Commerce and Industry, to keep records of their transactions, to give priority of delivery to the demands of the public services and to keep their books open at all times for inspection by government agents. The penalty for failure to observe these conditions entailed the cancellation of the license; but, so long as they were performed, the importer's right remained one of which he could not be deprived.

Perhaps the capital feature of this law was the creation of the "Office National des Combustibles Liquides." This new service was attached to the Ministry of Commerce and Industry and was intended to centralize and direct all of the activities relating to the oil trade of the nation. Its direction was confided to a director assisted by a board of 31 members representing the Senate, the Chamber of Deputies and the Ministries of War, the Navy, Public Works and Commerce and Industry. But, however important the Office National may have been regarded by the framers of the law, it is certain that its prominence in the economic fabric of the country may be ascribed wholly to the clairvoyance and wise administration of its distinguished Director, Colonel Louis Pineau, who has had to resolve the complicated problems and contend with the innumerable difficulties attendant upon the launching of a new enterprise and who has not infrequently been handicapped by discordant and conflicting legislation.

Despite the enactment of the law of January 10, 1925, and its tacit recognition of the oil trade as belonging to the domain of private enterprise, partisans of the idea of declaring it a state monopoly had not yet abandoned the fight. The question had been accorded a serious and extended investigation in 1919 by the Clemenceau Cabinet which, however, did not reach any definite conclusion. But on April 4, 1926, there was voted a law specifically transforming the petroleum industry into a government monopoly. It provided that the importation of crude oil and its products could be effected only by the state itself, or by persons duly authorized to act for its account, while all licenses or

H. O. Beatty, Paris correspondent of WORLD PETROLEUM, *whose sudden death on April 14 is deeply regretted by his many friends in the petroleum industry.*

authorizations granted under the law of January 10, 1925, would cease to be valid on and after April 1, 1927. No effort, however, has been made to give effect to the intent thereby expressed. As a matter of fact the question was agitated again in 1933 when a special commission was named to consider it, a commission consisting of representatives of the Parliament, of the various administrations interested and of the consumers' associations. After an exhaustive study of the problem in all of its aspects, the commission pronounced itself as definitely opposed to the idea of a monopoly, yet quite as definitely in favor of "controlled liberty," which is the underlying principle of the law of March 30, 1928.

The preamble to this law does actually make specific reference to that of April 4, 1926, and purports to bring it into practical operation by defining a new class of import licenses designated as special. It does not affect in any way the general licenses created in 1925, which continue to be available to any person desiring to apply therefor. Consequently the principle of state monopoly remains a dead letter.

Special licenses or authorizations are divided into two categories, the first applying to refined products, the second applying to the importation of crude oil. To obtain a special license, it is necessary for the applicant to agree to import a minimum of 300 tons per month. In case his application relates to refined products, the period of its validity is limited to three years. In the event that he intends to import crude oil and set up a refinery, the license may be granted for a period of 20 years. For all importations of less than 300 tons per month, whatever their nature may be, whether crude or refined, the applicant must still have recourse to the general licenses of 1925.

The definition of the new class of special licenses was the procedure devised to give practical expression to the inducement offered the industry to construct and operate refineries in France.

The special three year license covering only refined products was in reality no more than a provisional measure designed to protect those enterprises which might elect to construct refineries by offering them the means of continuing their business during the period of construction and while awaiting the moment when their plants would be ready to produce. The truly essential provision of the law was the 20-year license for the importation of crude oil.

The unexpressed intention of the legislature in retaining the general import license law of 1925 was to provide an arm against the formation of trusts and cartels among refiners looking toward the control of prices in a manner detrimental to the interests of the public. It was felt, and quite rightly so, that if any attempt were made in this direction, independent concerns, holders of general licenses, would at once invade the market with products priced on a basis which would immediately restore a proper equilibrium between cost of production and sale. At the same time it was expected that through the play of certain privileges and advantages enjoyed by the refineries in respect to taxation, they themselves would be protected against any attempt of the general licensee to bear the market down to a point where the former would find their investments and operations jeopardized.

The sum total of the foregoing legislation has been to subject the operation of the oil industry to a system of licensing divided into the three following classes:

(a) General licenses of unlimited duration for the importation of crude oil or of any of its products provided the amounts imported do not exceed 300 tons per month.

(b) Special licenses, valid for a term of three years covering imports in amounts fixed by the government in excess of 300 tons monthly, but limited to refined products only.

(c) Special licenses, valid for a term of 20 years, restricted to importations of crude oil only in yearly amounts fixed by the government and specified in the license. These are the licenses held by the refiners.

BEFORE directing attention to the problems whose origin may be traced to the conflict between special and general licenses, it is necessary to notice a special feature, that relating to the government's interest in one of the private enterprises of the trade, a feature which has a marked influence in the determination of market conditions.

In conformity with the accord reached between the British and French governments at San Remo in 1920, the former ceded to the latter a one-quarter interest in the Mesopotamian oil fields. Subsequently, in 1923, and in order to give effect to this cession, Great Britain invited France to take up approximately one-quarter representation in the directorate of what was then known as the Turkish Petroleum Company, but which has since become the Iraq Petroleum Company. In order to avail of the invitation thus extended to it, the French Government proposed to Col. Ernest Mercier, then President of the Syndicat Français des Etudes Pétrolières, that he form a private company which might represent the government's interests acquired by virtue of the San Remo accord. The result was the formation in 1924 of the Compagnie Française des Pétroles in which the government took a 30 percent interest. This was followed a year or two later by the organization of a subsidiary company known as the Compagnie Française de Raffinage in which the interests participating in the first named organization were proportionally preserved. In 1931 the government declared that in view of the participation of the Compagnie Française des Pétroles in the Compagnie Française de Raffinage, it would take the steps necessary to permit the latter to refine a quantity of crude oil yearly equal in amount to 25 percent of the totality of declarations establishing the tonnage of finished products offered to the public for consumption. In other words, the government reserved to the Compagnie Française de Raffinage 25 percent of the market demand. Consequently, so far as regards the strictly private companies engaged in business previous to 1928, their market was reduced to 75 percent of national consumption. This was further reduced by the grant of special licenses to newcomers without vested rights so that the percentage of the demand that both may supply stands at present at about 60 percent of the whole.

THERE have been issued and are actually outstanding some 1,250 general licenses which represent a possible importation of 4,500,000 tons of petroleum products annually. While the tonnage of shipments under these licenses is far less than the quantity authorized, it can none the less be increased to the full amount at any time that it may be desired. Indeed there is no limit to the amount to which it may be carried, since there is no limit to the number of general licenses which may be accorded. Any applicant is entitled to such a license on demand. All that is required of him is his agreement to fulfill the very simple conditions attached to the grant.

The total of special 20-year licenses for the importation of crude oil to be refined into gasoline amounts to 1,923,000 tons annually. This tonnage does not include the 25 percent reserved to the Compagnie Française de Raffinage. The total of special three-year licenses for the importation of gasoline amounts to 2,630,000 tons annually. Inasmuch, however, as the three-year licenses are held by refineries either operating or to be operated under the 20-year licenses and have been obtained only to make up deficiencies in the refinery output during construction, the total possible importation under both classes of special license is not the sum of the two. It is something less, and may be estimated for this year in round figures at 3,000,000 tons. The results of the operations for 1934 show that the market consumed 2,350,000 tons of gasoline. Since every indication points to a decrease of demand in 1935, it is evident that the supply from this source alone will be much more than sufficient to satisfy all national requirements. Importations under general licenses, therefore, will merely serve to glut an already saturated market.

As has been observed, the government fixes the amount of crude oil or its products which may be imported yearly under special license. Its aim in calculating the amounts of those now in force was to arrive at an aggregate commensurate with the national need. This was arrived at by selecting the tonnage business done by each applicant during the most favorable of the five preceding years and increasing it by 30 percent. This naturally authorized a productive capacity well in excess of probable sales capacity, an excess which was designed to meet a double purpose. In the first place it would provide a wide margin of security to meet the demand of any unusual emergency. In the second place it would permit the refiner to keep pace with what was hoped would be a steadily growing market.

It seems to be fairly evident, and certainly it is logical to suppose, that, in voting the law of March 30, 1928, the legislature deemed its provisions largely sufficient to respond to every national necessity both ordinary and extraordinary. It must have been considered as supplanting the law of January 10, 1925, for all practical purposes. Doubtless it was assumed that applications for general licenses would cease and that those issued would lapse in most instances, since it was estimated that the tariff preference in favor of the products of imported crude oil would give them an advantage over the directly imported article. The law of 1925, however, was allowed to stand, primarily for the protection of certain small importers unable to construct refineries, but who had an established position in the trade and who had acquired definite market rights of which it would have been inequitable to deprive them.

That the law of 1925 was expected to lapse through disuse seems all the more apparent when we consider the underlying motives for the enactment of the law of 1928. They were twofold. The first and compelling motive was to assure not simply adequate, but abundant, provision for the paramount needs of national defense. To possess on French soil at different strategic points modern refineries of aggregate capacity far beyond any possible demand, whatever the necessity, and to possess as well generous stocks of crude material and refined products offered the maximum of security for all defense purposes. Of secondary importance, yet nevertheless a motive of decisive character, was the desire to introduce a new enterprise to the nation productive of profit to French interests, productive of profit to the state and capable of furnishing employment to large numbers. Bearing these facts and considerations in mind, it is wholly illogical to suppose that the government anticipated the importation of any tonnage of consequence by the holders of general licenses. Yet this is precisely what has happened.

The laws as they stand at present place the refiner, as compared to the importer, at a great disadvantage. His overhead costs are extremely heavy. He has the burden of a large investment on which interest must be paid and in addition he must make provision for his amortization

charges. He has, moreover, a costly organization to support and is obliged as well to maintain or to employ an extensive distributing system. Finally he must pay an inland transportation charge on the products of his refinery after having paid an ocean transportation charge on his crude oil. The sum of these expenditures is compensated to hardly any extent whatever by the tariff preferential accorded him over the general licensee whose overhead expenses are practically non-existent, whose investment, if any at all, is insignificant, who possesses as a rule no distributing system and who pays but one transportation charge to bring his wares to his customer's door.

The experience of the past has demonstrated that as often as market conditions have been improved through the efforts of the refiners, speculators have immediately appeared in the guise of general licensees to reap an easy and assured profit from their advantage and to retire as soon as the confusion that they produced rendered further operations undesirable. A remedy for this abuse was sought in the law of April 14, 1932, which, among other things, modified the law of January 10, 1925, by requiring applicants for general licenses to show that they possessed the means for the fixed and permanent storage of the reserve specified by the law. Since, however, the law did not oblige them to own their storage facilities, no objection could be raised if they were rented from another. And it was here that unemployed capital discovered an excellent opportunity for a safe and profitable placement.

It was quite apparent that capital employed in the construction of tanks and reservoirs would enjoy an almost absolute measure of protection against loss or shrinkage. As soon as construction was commenced at any point, it was found that there was no lack of persons or companies desirous of renting. The material stored constituted an entirely safe guarantee for the payment of rent since it was of considerable value and not subject to any appreciable variation. The direct consequence of this new line of enterprise was to increase the issuance of general licenses. For the most part they were allotted to persons or concerns with the bona fide intention of engaging in the business for themselves. Latterly, experience has shown that many applications were granted to mere intermediaries whose only interest was the franc or two per ton that they received for the use of their name paid by foreign concerns anxious to invade the market, but unwilling to submit to the conditions imposed on those legitimately established in France.

These constructions, known to the trade as *entrepôts banaux*, a term for which there is no exact English equivalent, add greatly to the complexity of the problem. They represent a large investment of capital, a capital invested in perfect good faith and in conformity with the apparent policy of the government as indicated by the laws in force. Such a capital has every right to demand protection. As to this fact there appears to be no dispute.

Nor does there exist at present, either in the oil industry itself or among the civil authorities, any question as to the imperative necessity of finding some means of relief for a situation which is highly detrimental to the best interests of the nation and which is becoming daily more critical. It is recognized as unjust and unfair that the refining interests, whose investments total several thousand millions of francs, should suffer losses running into the hundreds of millions each year, especially in view of the fact that their investments were made largely at the solicitation of the government in order to give effect to its desire to fortify both national security and national economy. It is fully realized that neither national security nor national economy can be served or promoted by an industry which has ceased not only to be prosperous but which is harassed by grave danger.

Although an adequate remedy for the plight of the refiners might be found in the repeal of the law of January 10, 1925, and the cancellation of all general licenses, such a remedy would work an unjustifiable hardship upon many of the smaller enterprises whose long establishment and absolute good faith unquestionably entitle them to the same consideration as the refiner himself. It would likewise work an unjustifiable hardship on those who have contributed their funds to the construction of storage tanks and reservoirs. Practicaly indeed, it would result in their confiscation. So, while there is an entire unanimity of view as to the need of a remedy, there is a wide divergence of view as to the definition of its nature. It must be such as will relieve not only the refiner, but will at the same time protect the opposing interests of the general licensee and the owners of the *entrepôts banaux*.

In this connection there is one point upon which there is no conflict of opinion. As has been remarked above, some 1,250 general licenses in all have been issued. Only 160 have ever been used. Consequently there are 1,090 held for purely speculative purposes. These latter might be cancelled without injustice, for the speculator should not command sympathy. He is merely a parasite. The same may be said with reference to the general licenses obtained and held for the benefit of organizations located outside of the country and which have been operating through the agency of an intermediary. In deducting these two classes, the field is narrowed to the general licensee whose past operations have been wholly legitimate and have established for him vested rights of which he cannot be deprived without proper compensation.

It is generally conceded that the latter's license should be transformed into a three-year special importing license with a fixed and determined maximum tonnage. The difficult matter, though, is to find the basis upon which that tonnage should equitably be calculated. On the one hand, it is proposed to estimate it on the basis of the tonnage which his means of storage will allow him to import. Since the importer is required to hold a reserve equal to 25 percent of his yearly importation, his authorization would amount to four times his storage capacity. A tonnage so determined, however, would give a marginal possibility in excess of any probable importation of unreasonable magnitude. Its existence, moreover, would open wide the door to the speculation from which the market has suffered already so disastrously and which for every reason of sound policy it is essential to suppress.

On the other hand, it has been proposed that the same basis of calculation be adopted in transforming the old general licenses into new special licenses as was employed in fixing the tonnage amounts allocated to the first special licenses issued under the law of March 30, 1928. This, it will be remembered, was accomplished by ascertaining the tonnage imported during the most favorable of a specified series of years and then increasing it by 30 percent for the purpose of anticipating the expected expansion of business. Business, as a matter of fact, has expanded since that time by about 10 percent of its former volume. Therefore, in order to accord the same advantages to all holders of special licenses, the original coefficient of increase would be changed to 20 percent in estimating the new authorized tonnages. From the standpoint of an observer, we should say that this method would be eminently fair. Everyone would be placed upon exactly the same standing of equality. While it is evident that an excess margin would be created, it would still be sufficiently restricted to discourage speculation. At the same time it would be sufficiently wide to allow for any growth of business, however extensive, which better times may bring in its train.

If we suppose, as will doubtless be the case, that a basis of calculation be chosen which assures an equality of treatment in the assessment of the tonnage authorized

to be imported, there will still remain the necessity of according an equality of position on the market to the refiner as distinguished from the importer of refined products. The tariff preferential, of which we have spoken, will have to be increased so that the locally refined product does not remain at a marked disadvantage on its home market when sold in competition with the imported article. It is not simply from the point of view of meting out equal justice to both classes of operator that the suggestion seems to us opportune. There is the yet larger and more important interest of the public and the nation to be reckoned with. The industry is an essential one to the country, both with regard to its economic well being and to the requirements of its national defense. And the refiner is the backbone of that industry. So long as he is placed in a position of inferiority, so long as he is forced to meet this competitor on an unequal footing, so long as his investment is thrown into jeopardy, just so long will conditions continue in their present precarious state. No possible advantage can accrue either to the nation or to the public by prolonging so unfortunate a situation. The prosperity of the industry is one of the fundamental factors necessary to the peace and security of the commonwealth.

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Congressional Action on Oil Uncertain

Texas Leads Fight Against Federal Control—Ultimate Result May Depend on President's Action —Opposition Develops to Proposed Form of NIRA Extension.

By Don J. Kirkley

WASHINGTON, APRIL 30

BEFORE members of Congress close their desks to go home in July or August they may find time to approve some oil legislation. The form that it will take is still uncertain but the probabilities are that the terms of the Thomas bill now pending in the Senate will be materially modified before that measure is placed on the statute book—if it ever reaches that goal. There is a sharp division between the advocates of federal regulation and those who would confine Congressional action to ratification of an interstate compact with no provision for interference by the central government except for a possible extension of the Connally act preventing interstate shipment of illegally produced oil.

Broadening of federal authority is supported by the Oil Administration and by a considerable segment of the petroleum industry. It is opposed by the official representatives of Texas including Representative Rayburn, chairman of the important Interstate Commerce Committee of the House of Representatives, by the American Petroleum Institute and by many of the major oil companies.

Following a recent conference on oil at the White House a report was circulated that the President would take vigorous steps to bring about adoption of an effective measure of federal control and that he would send a special message on the subject to Congress. It has since been denied that such a message is contemplated. With many important features of his general program still unacted upon the President may not be disposed to take a direct hand in a bitter fight over oil.

Battle lines were drawn at the hearings on the Thomas bill held by a sub-committee of the Senate Mines and Mining Committee, beginning April 16. Texas, through Governor Allred, demanded the death of the bill as an invasion of states' rights. Official spokesmen for Oklahoma and California aligned themselves with Texas. The three states, between them, account for about 80 percent of domestic oil production.

Axtell J. Byles, president of the American Petroleum Institute, advocated the interstate compact and opposed other features of the Thomas bill. The only legislation necessary, he said, was provision of a federal fact finding agency, limitation of imports in proportion to domestic curtailment and regulation of interstate shipments as provided by the Connally act.

Oil Administrator Ickes and the others who spoke for the bill said it was needed to prevent industrial upheavals and economic instability, that the states could not handle the problem, and that the proposal to regulate shipments of crude and its products was constitutional. In support appeared:

Amos L. Beatty, author of the quotas-in-commerce plan; J. D. Collett and C. F. Roeser, Texas oil operators; Russell B. Brown, general counsel for the Independent Petroleum Association of America which is advocating the bill. Statements from Governor Landon and Senator Capper of Kansas, endorsing the bill, were filed.

The Subcommittee of the Senate Mines and Mining Committee finally, on the last day of April authorized a favorable report on the Thomas Bill with certain changes. These changes include provision for federal allocation of production, quotas to be based on conservation and prevention of waste as well as on economic requirements. The federal board making these allocations is given authority to enforce the quotas if state agencies fail to comply in enforcing restriction of production. A federal board of five members would be appointed by the President and would operate under the direct supervision of the Secretary of the Interior (who, however, would not be a member). This board would be authorized to fix quotas in commerce for states, fields and down to individual wells in cases where their investigation indicated that the uncontrolled flow from any well was disrupting the stability of interstate commerce.

The bill as approved by the Senate Subcommittee approves of interstate compacts for the regulation of production. It provides, however, that all records of interstate compacts be filed with the federal board.

The preamble of the bill revises and changes the declaration of policy by providing regulation of production on the grounds of national defense, economic

welfare of the nation and conservation of national resources.

It is anticipated that the full committee will report the bill in about ten days (about May 13).

The anticipated report thus leans more nearly toward what Administrator Ickes wants than toward the views of the no-regulation group.

But, although the immediate theatre of action is in the Senate, where every effort is being made by opponents to prevent a vote, the real battleground remains the House of Representatives, symbolized in the Cole Committee, which is a subcommittee of the Interstate Commerce Committee, and in the latter Committee itself.

Representative Cole is definitely on record as opposed to the Thomas Bill as it originally stood and has indicated some doubt as to whether it will be acceptable if revised as expected, but awaits a glimpse of whatever comes out of the Senate before going into that question.

Unless the Senate gets into a legislative jam as is not improbable the bill as finally reported is expected to pass.

On the House side a justifiable guess is the possible enactment of a bill limited to the following:

1. Ratification of a compact.
2. Some provision for determining national demand and compiling production data.
3. Limitation of imports.
4. Probable authority for the President to consolidate some or all federal agencies dealing with oil, gas, coal and other mineral resources.
5. Reenactment of the principle of the Connally law, which expires in 1937, as an amendment to provide permanency.
6. Probable elimination of the quotas-in-commerce plan.

On that side, the fight will be to get the bill, as it may be whittled and shrunk, out of the hands of a committee, with opponents ready to place every possible obstacle in its path.

In all the excitement over the Thomas bill, Washington and the industry at large have generally overlooked two other important developments in April which may have their final results written in May and June:

A declaration of general hostility toward the Harrison-Administration NIRA extension bill as drafted, presented for the Planning and Coordination Committee to the Senate Finance Committee by Louis Titus, counsel, who said in summarizing:

"The President has the power under this bill to write an entirely new code without any reference to or any action by the industry."

In other respects, Titus said, the proposed bill would eliminate industrial authority for self-government and vest all authority in the President. He contended the industry had satisfactorily shown its right to self-regulation.

The points which Mr. Titus found objectionable probably will be considerably modified before the Finance Committee takes the bill to the floor for consideration, as other industries have expressed similar views.

All the public lands states of the West, in which the Government has about 200,000,000 acres of land, are closely following the bill introduced for the Administration by Senator O'Mahoney and Representative Greever, both of Wyoming, to amend the mineral leasing law of 1920 to require larger royalties and competitive bids.

It is anticipated that the proposed draft will be considerably revised before being approved. The Interior Department has extended until August 1 all existing permits, most of which would have expired on May 1, so as to permit full consideration.

Attention to the Thomas bill has momentarily delayed plans for thorough consideration by the industry through the Planning and Coordination Committee and the Petroleum Administration, of the Blazer Committee's report. Present plans are for a joint discussion to be opened early in May, so that the recommendations may be taken up with a view toward determining the extent to which they might be incorporated into the new code.

Another matter on which the petroleum industry will keep an eye in May is the program of Representative Morgan Sanders of Texas to reenact prevailing excise taxes on foreign oils and increase the crude tax to a cent a gallon. This question is likely to come up before the House Ways and Means Committee before the month ends, along with the recommendation of Representative Lloyd of Washington for a fuel oil tax.

The outlook for these is: defeat of the fuel oil levy and the increased crude tax; probable reenactment of the other excise taxes.

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Increased Strength of London Shares

Royal Dutch and Shell Shares Advance—Increased Dividend Rumored. Position of Mosul Oilfields. March Petroleum Imports Decline.

QUOTATIONS for oil shares on the London Stock Exchange have improved during recent weeks, and the market has taken on a definitely firmer undertone, with interest largely concentrated on Royal Dutch and Shell.

A higher quotation for Royal Dutch is a natural corollary of doubt, engendered by the devaluation of Belgian currency, as to Holland's ability to maintain the guilder at its former gold parity. Dutch currency, in which Royal Dutch dividends are paid, has declined in terms of sterling, and this would normally make for a lower sterling value for the shares. In the share market, however, the predominant factor has been the demand for the shares in Holland, born of the widespread desire to turn currency into any assets likely to retain their nominal gold value. This demand raised the London price of Royal Dutch from 20 to 21¼ in a single week at the beginning of April.

An additional influence, which has affected Shell as well as Royal Dutch, has been discussion of the possibility of an increase in the 1934 dividends of these companies. Needless to say, no official encouragement has been given to talk of this kind, and an examination of the published facts concerning the companies leaves some doubt as to the likelihood of increased distributions.

Royal Dutch and Shell dividends are due for declaration next month. They will compare with 7½ percent free of income tax, and 6 percent respectively paid for 1933. As the two companies are combined on the basis of 60 percent interest by the Dutch concern to 40 percent by the British, the same influences have operated equally on the fortunes of both of them. Although outputs have evidently risen in the Dutch East Indies and Venezuela, in no major section of the Group's activity is there conclusive evidence of larger profit earning. In the United States, on the other hand, the quarterly reports of Shell Union provide no ground for expecting a larger income for the combine, while the difficulties arising from the Amatlan law suit encountered by Mexican Eagle, the principal Mexican representative of the Group, suggests a leaning towards conservatism in distributing the profits of Royal Dutch and Shell.

World oil prices, although recently showing a better trend, would not by themselves encourage hopes of increased distributions, and selling prices in many markets, including Great Britain, have been unsatisfactory during the past year. It is also well to recall that both the Royal Dutch and Shell companies passed their interim dividends for 1934, thereby following the practice adopted in the preceding year.

Such adverse influences as have operated may have been offset to a considerable extent by economies in production, transport and distribution. With its world-wide producing and selling organisation, the Royal Dutch-Shell group must offer unique scope for economical planning, and it is therefore conceivable that further reductions in costs in 1934 have made an appreciable difference to the profits of the group. The management, in addition to being far-sighted and astute, is nevertheless cautious in finance, and in view of the currency and other uncertainties prevailing, it would probably be unwise to back a belief in a dividend increase too heavily.

Apart from the dividend anticipations already mentioned, the oil share market has derived some support from rumours of a coming rise in motor spirit prices in Great Britain. Possibilities in this direction have probably been brought under discussion by the recent slight strengthening of Gulf and Roumanian export prices. It will be recalled that the last reduction of 1d. per gallon a year ago, bringing British prices quoted by the national group down to 1s. 5d. per gallon for the England and Wales area, was said to be largely due to the necessity for discouraging the operations of the smaller independent distributors. There can be no doubt that higher prices are called for in order to make the British market profitable. That consumption is increasing at a very satisfactory rate is evident from the import statistics and also from the Board of Trade figures showing motor spirit entered for home consumption. The home consumption total for February 1935, at approximately 2,374,000 bbl., represents an advance of 5.6 percent on February 1934, with the same number of working days in each month. The national companies, moreover, are said to be increasing their share of the total business. But with prices at their present level, the gain in consumption means little or nothing to distributors from the profit-earning viewpoint.

Higher Gulf and Roumanian quotations should, on the face of it, leave less margin for independents in the British market operating by casual purchases, and to this extent the position has recently been more favourable to an upward adjustment of motor spirit prices. It was reported early in April that one of the regular distributors outside the national group had increased quotations in some Midland districts.

Outside the motor spirit market, some notable movements have taken place in kerosene prices since the beginning of the current year. Published prices for the best grades remained at the level of 8½d. per gallon established last July until early in January, when they were advanced to 9d. While the steady increase in the British demand for kerosene is attributed to the mechanisation of farms, calling for larger kerosene consumption in tractors, a considerable proportion of the total consumed is still due to requirements for heating. One estimate puts the heating demand at 50 percent of the total. A cold winter in Britain would doubtless have brought about an earlier improvement in published kerosene selling values, but exceptionally mild weather in December kept the demand down, and seems to have created something of a panic among some of the smaller independent distributors, who realised their stocks at low prices. This had the effect of bringing down the levels at which the larger companies were prepared to deal, and thus delayed any improvement in the published quotations on which actual business is based. Even when operative, the January advance in kerosene to 9d. per gallon proved to be short-lived, for the price was reduced again to 8½d. in March, with every indication of ample stocks available in the British market.

Mosul Oilfields Position

RETICENCE on the part of directors of an undertaking such as Mosul Oilfields Limited is bound to lead to the circulation of rumours from time to time, and the British Press has recently been busy with the affairs of the company.

It has been stated that developments on the company's property, owned through its holding of the shares of B. O. D. Company Limited, have not fulfilled expectations, and that the company has fallen behind with its dead rent payment of £150,000 (gold) to the Iraq Government, due at the beginning of 1935. It has also been reported that the government was by no means satisfied with a payment on account, and that the payment was completed at the end of March, the remittance with interest amounting to £260,000 sterling. Italian interests in Mosul Oilfields are said to have provided a larger proportion of the payment than usual owing to the failure of the German end of the company to provide its quota in cash, and it has further been announced that 52 percent of the capital is now in Italian control.

The facts are that considerable latitude in making the dead rent payments has always been envisaged by the company, with the full concurrence of the Iraq Government. This arrangement is due to the fact that the remittance of a considerable sum in gold exchange can often be achieved on the most favourable terms when purchases of exchange are made at the correct moment, and are not effected in a single operation. Under the arrangement, interest is charged on any amount not remitted at due date, the Iraq Government taking the view that interest may just as well be paid by Mosul Oilfields as by the bank in which the funds, if handed over by the company immediately, would have been lodged and kept for a time.

As far as developments on the field are concerned, the company's concession, on the West bank of the Tigris, extends over 46,000 square miles, and the testing carried out so far can only have covered a very small proportion of the total. It is stated from an authoritative quarter that the company has up to the present met with no striking successes and no serious disappointments, and that developments to date are insufficient to provide any reliable indication of the exact ultimate value of the whole property as an oil bearing proposition. During 1934 B.O.D. Ltd. produced 25,051 bbl. of crude from its Iraq wells and used 8,323 bbl. in its own operations.

Beyond this, nothing like an official statement is forthcoming, and the company is undoubtedly within its rights in regarding itself as a private concern with no obligation to make statements outside the circle of its own shareholders. Al-

though this circle is limited, the international groups composing it are important enough, with the proximity of the field to the successful Iraq Oil enterprise, to invest Mosul Oilfields Limited with an interest which will sometimes evince itself in rumour and surmise if it is not kept satisfied by the publication of official information.

British Imports Decrease

TOTAL British oil imports for the month of March show a decline of 14 percent as compared with figures for the corresponding period of 1934. While all principal oil products showed a decline, smaller shipments of Dutch West Indian fuel oil was the principal factor in the March decline. Crude oil imports during March actually showed an increase compared with 1934 and crude imports for the first quarter of 1935 ran slightly ahead of crude imports for first quarter, 1934. While Persian shipments to England declined in March, other countries sent 962,000 bbl. compared with no shipments in the first quarter of 1934, due no doubt to importations from Iraq and to the fact that due to German exchange difficulties, countries formerly shipping to Germany are diverting their cargoes to England where crude is refined and shipped to Germany from whom Great Britain can collect funds through Anglo-German.

British Oil Imports By Products
(Barrels)

	March 1935	Three months to March 31 1935	Three months to March 31 1934
Lamp oil	497,886	1,612,139	1,943,459
Motor spirit	2,649,571	7,939,857	7,530,086
Lubricating oil	184,314	552,801	693,660
Gas oil	207,344	966,233	1,033,254
Fuel oil	1,076,657	4,012,885	4,301,770
Other sorts	63,342	162,999	177,200
Total products	4,679,114	15,246,914	15,679,429
Crude	1,008,400	3,120,943	2,837,714
Total imports	5,687,514	18,367,857	18,517,143

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Business Revival Stimulates German Consumption

Government Encouragement of Automobile Use And More Than Adequate Protection for Domestic Production of Limited Quantity Places German Industry in Profitable Position.

By Dr. Norbert Lauffs

THE REVIVAL of German business during the past year had a very favorable effect on the petroleum market; an increase of 20 percent in consumption is something to be regarded as notable even in a period of expansion. This increase in the use of power-fuel was to be expected from the efforts of the government to promote road traffic, but it has turned out that industry, manufacturing and agriculture have all shown greater capacity for taking petroleum products than the automotive traffic. Table I shows the mineral oil consumption in the past two years.

The number of automotive vehicles in use has greatly increased, due to removal of the tax on passenger cars put in actual use after March 25 and to the prospect that the tax would eventually be lowered on older vehicles; reduction in cost of insurance; the lowering of registration fees; repair and extension of the road systems; and last but not least, direct action by the government to promote motorization of road traffic. At the end of 1932 there were only about 400,000 passenger cars and 143,000 delivery cars and trucks in use. When the new measures came into effect, cars that were previously laid up began to reappear, and by July 1 there were 522,209 passenger cars and 155,219 delivery cars and trucks on the roads. In the last half of 1933 the new situation began also to have an effect on the market for new automotive vehicles. By the end of the year the trade in new cars had improved by 12 percent and the improvement was carried over increasingly into 1934, so that the automotive industry even encountered difficulty in making deliveries. By July 1, 1934 the number of passenger cars in use had increased to 607,591, and the commercial vehicles to 168,712; thus the trade in these two classes registered improvements of 16.4 and 8.7 percent respectively in the twelve months, with the result that the usual seasonal slack in this industry was little felt during the fall of 1934. This continuance of the demand for cars had the fortunate result that the automotive industry could keep its working force fully occupied, with no lay-offs.

Table I

Germany's Mineral Oil Consumption in 1933 and 1934

Product	Tons 1933	Tons 1934	Percent increase
Light power-fuels (gasoline, benzol, alcohol)	1,400,000	1,650,000	17.9
Special and high-test gasoline	100,000	125,000	25.0
Lamp oil	120,000	120,000	....
Gas oil	480,000	650,000	35.4
Lubricating oil	280,000	365,000	30.4
Fuel oil	320,000	330,000	3.1
Bitumen	200,000	290,000	45.0
Total consumption	2,900,000	3,530,000	21.7

The increase of the number of power vehicles in use is naturally a sign of economic revival only to the extent that use is made of them. When the new measures were put into operation there was some fear that they would have little effect on the new car market, because the general financial situation would still make purchase, operation and maintenance difficult. However, these fears proved to be largely groundless. The consumption of fuel by power vehicles, which is a reliable measure of the intensity of use of these vehicles, increased in about the

same proportion as the number of cars on the road. Whereas in 1933 the consumption of the lighter fuels was about 1,400,000 tons, the next year it had increased to 1,650,000 tons, from which it has been figured that the average mileage of an individual car in this year was greater than in 1933. The new cars, on the whole, have smaller motors and are also more economical. It is further to be considered that the consumption of the lighter fuels is not the only basis for calculating intensity of employment of German power vehicles. The spreading use of Diesel motors for trucks has increased the use of gas oil, which in 1933 was about 20,000 tons, to 60,000 tons in 1934. At the present time practically all heavy trucks and most of the lighter ones are being equipped with Diesel engines.

Although the heavy Diesel fuels are almost exclusively imported, requirements for the lighter power-fuels are largely being met by domestic production; the domestic producers have supplied this increase in the demand. Production by the Leuna hydrogenation plant of the I.G. is steadily increasing; during the last year this plant turned out about 150,000 tons of gasoline. An enlarged demand for coke has also favored an increase in benzol production. The benzol output of the coking ovens in 1934 was about 240,000 tons, against 202,000 tons in 1933. Distillation of tar yielded about 25,000 tons compared to 23,000, and the gas factories produced somewhat between 15,000 and 20,000 tons. In total, the entire German production of benzol in 1934 was between 280,000 and 290,000 tons, which is about 40,000 in excess of the 1933 production.

The admixture of 10 percent of alcohol with all lighter power-fuels is obligatory, so that the quantity of alcohol used in this way is governed by the total fuel consumption. In 1934 about 170,000 tons of alcohol came on the power-fuel market (previous year 137,000 tons). The total consumption of alcohol for other purposes remains constant, so that the potato distillers have the fuel market to thank for their increased business, which will undoubtedly be still larger in 1935.

The domestic petroleum-gasoline production of the past year was higher than in 1933. The increase from 65,000 to 70,000 tons is a natural consequence of the development of Prussian oil production, which in 1934 amounted to 312,852 tons (in comparison with 232,689 tons in 1933). The largest producer of petroleum-gasoline is the Gewerkschaft Deutsche Erdolraffinerie (Deurag) in whose Misburg plant there was produced 54,000 tons in 1934, and 47,000 tons in 1933. The rest was produced by a number of smaller operators.

Also to be mentioned as a producer of gasoline is the brown coal distilling industry, which produced about 8,500 tons in 1933, but owing to the increased demand for its main product was able to deliver about 10,000 tons.

The total domestic production of lighter power-fuels in 1934 amounts to 650,000 tons. It is thus about 140,000 tons above the production of 1933, taking care of 56 percent of the increased demand which amounts to 250,000 tons. The remaining 110,000 tons must be covered by imports. The importation of power-gasoline (duty paid) was 905,000 tons in 1933 and 1,010,000 in 1934.[1]

The high German tariff on power fuels, amounting to RM. 21.93 per 100 kg. for gasoline and RM. 20.40 per 100 kg. for benzol, and the small compensating tax of RM. 3.80 per 100 kg. for gasoline and benzol, naturally make a large difference between the price received by the domestic producers for their product and what must be paid for the imported goods. The 1,001,000 tons of imported gasoline cost (c.i.f. German port) RM. 55,000,000 whereas the German producers received not less than RM. 236,000,000 for 650,000 tons of lighter power fuels.

It is erroneous, however, to regard the last named sum as equivalent to the cost of producing the 650,000 tons of domestic power-fuel. The domestic cost of production shows wide differences. The cost of producing benzol cannot be stated, as benzol is a by-product. However, a careful study of the matter shows that the existing high tariff differential is not at all necessary to assure profitable benzol production, and the same is true for the larger part of the German petroleum production. The only branch of the German power-fuel industry that needs such tariff protection is the Leuna hydrogenation plant, where a liter of gasoline costs about 20 pfg.

Power alcohol is naturally an exception; the price that has to be paid for this product is far higher than the price of duty-paid gasoline, or that received by the most unfavorably situated German petroleum producer. It is estimated that the extra burden laid on the German power-fuel users amounted in 1934 to more than RM. 100,000,000 and this burden will naturally increase proportionally as more fuel is used. Only about 5,000 agricultural distilleries benefit from the enforced use of alcohol-fuel, which is of no real general benefit to potato growers. The production by these distilleries is fairly constant and is independent of the size of the potato crop.

It is difficult to give a clear picture of the market for the heavier power fuels. The German production statistics give no information as to heavy power-fuels from the distillation of brown and stone coal, but the writer's private inquiries, extending over a period of several years, lead to an estimate that during the past two years about 30,000 to 40,000 tons annually of this grade of motor fuel have been put on the market. In precisely what industries this material has been used is difficult to say.

On the other hand it is possible to give particulars regarding the use of gas oil from foreign petroleum, of which 621,630 tons came on the market in 1934 (previous year 490,556 tons). To this is to be added about 36,000 tons of German origin (30,000 t. in 1933). Of this approximately 650,000 tons of gas oil about 50,000 tons were used for bunkering, 60,000 tons were employed in automotive vehicles and between 420,000 and 440,000 tons in stationary and other engines.

Table II

German Power Vehicles in Use, 1928–1934

(Fiscal year begins July 1)

Year	Passenger cars	Delivery cars and trucks	Motor cycles (over 200 cc)	Motor cycles (under 200 cc)	Other power vehicles	Total
1928	351,380	121,765	334,314	103,974	21,879	933,312
1929	433,205	143,952	385,863	222,479	28,560	1,214,059
1930	501,251	157,432	422,186	309,051	29,947	1,419,867
1931	522,943	161,072	417,569	374,506	31,039	1,507,129
1932	497,275	152,420	385,619	433,559	30,851	1,499,724
1933	522,209	155,219	374,175	478,601	32,619	1,562,823
1934	607,591	168,712	393,923	539,840	35,818	1,745,884

Table III

Summary of Domestic Production of Lighter Power-Fuels

Product	Tons 1933	Tons 1934
Hydrogenation gasoline	100,000	150,000
Power-fuel benzol	200,000	250,000
Power alcohol	137,000	170,000
Petroleum and brown coal gasoline	73,000	80,000
	510,000	650,000

[1] Slight discrepancies in figures for consumption and supply in this article are due to changes in figures for warehouse stocks.

Since industry and manufacturing mostly use stationary engines these figures are an impressive reflection of the development of German industry in general. Another sign of improvement is a 25 percent increase in the consumption of special and high-test gasolines.

A much greater than average increase in consumption of lubricating oil is noticeable. Only a part of this increase is to be credited to the increase in automotive traffic; the rest is to be credited to an increased activity in general manufacturing. Out of 370,000 tons of lubricating oil used in Germany during 1934, somewhere between 20 and 25 percent was from German petroleum.

There has been a forward movement in the use of bitumen, due to the measures taken by the Reich government for improving and extending the road system. On the other hand the consumption of lamp oil and oil for heating purposes has remained about constant.

Table IV

Proportions of Domestic and Imported Mineral Oil on the German Market in 1934

Product	Tons Domestic	Tons Imported
Light power-fuels	650,000	1,010,000
Special and high test gasoline	———	125,000
Lamp oil	20,000	100,000
Gas oil	35,000	620,000
Lubricating oil	85,000	285,000
Fuel oil	20,000	330,000
Bitumen		280,000
	810,000	2,750,000

The entire domestic mineral oil production enjoys a tariff protection, which is not so great for the heavy mineral oils as it is for gasoline and benzol, but is still enough to ensure very profitable business. During the past year German industry paid about RM. 135,000,000 for the 2,700,000 tons of imported mineral oil that went into consumption, whereas the 800,000 tons of domestic production actually used cost about RM. 270,000.

Although the increase in consumption of the lighter power-fuels went to benefit the domestic producers the picture is different as regards the other products. The larger demand for gas oil, lubricating oil and bitumen had to be covered almost exclusively by imports. Consequently German petroleum imports in 1934 have considerably increased, shown in Table V.

The German exchange situation during the past year greatly stimulated efforts to enlarge the domestic production, even though difficulties attending importation of mineral oil products were not as great as in the case of certain other imported goods. This is mainly due to the fact that the great foreign oil concerns that are engaged in the German oil import business have year after year placed large orders with German industries which in 1934 amounted close to RM. 50,000,000; this has afforded a valuable counterpoise to the RM. 140,000,000 paid for the 3,154,611 tons of imported mineral oil. But even so, this generally recognized cooperation of the big foreign oil companies has still left the fiscal authorities and the importing companies trouble enough in raising the balance required. There is no present intention of displacing foreign oil from the German market. So long as the domestic production is attended by the present high costs, the relative inexpensiveness of the foreign products will assure to the import business a strong position.

Table V

Germany's Mineral Oil Imports in 1933 and 1934

Product	1933 tons	1934 tons	1934 in comparison with 1933 in %
Crude petroleum	280,620	276,717	— 1.4
Gasoline	1,004,758	1,158,385	+15.3
Lamp oil	97,483	98,261	+ 0.8
Gas oil	467,348	639,916	+36.9
Lubricating oil	276,399	322,033	+16.5
Fuel oil	310,838	316,180	+ 1.7
Residues, etc.	247,522	343,119	+38.6
Total	2,684,968	3,154,611	+17.5

The general difficulty with the exchange situation has stimulated a voluminous propaganda for a raft of petroleum substitutes. In most cases little importance can be attached to these propositions. So far, it appears that propane and butane, among the gaseous power-fuels, are the only products adapted for general use in automotive vehicles. Ordinary city gas will serve only in specially favorable cases, and the same may be said of the wood-gas generator.

As is always the case during an economic upturn, market conditions have been comparatively peaceful and the bitter competition of former years has not been so much in evidence. To judge from the market conditions at the end of 1934 the coming year will see a further increase in the consumption of mineral oil products. In the year just closed the usual seasonal let-ups have by no means been as great as in former years. This is partly due to the fact that winter use of automotive vehicles has lately been on the increase; another factor has been the further favorable development of German business.

▼

Manchukuo Monopoly Protested

WASHINGTON, APRIL 30—While the protests lodged with the Japanese government by the Department of State against the establishment of an oil monopoly in Japanese controlled Manchukuo apparently have had little effect on the situation thus far the matter is far from being regarded here as a closed chapter. Following up Ambassador Grew's original representations in behalf of the United States that the oil monopoly violated existing trade treaties reports on actual conditions in Manchukuo are being forwarded regularly and rumors of coercion of oil company representatives by Japanese agents are being investigated.

The matter of the oil monopoly is important in itself, but from the viewpoint of Washington the issue presented is somewhat broader than that, involving the growing spread of monopolistic practices under Japanese supervision. While there possibly is no direct connection with the oil matter the President's order to the Tariff Commission for a survey of Japanese competition in the cotton goods industry is an indication of the development of unsatisfactory trade conditions in that part of the world.

▼

I.P.C. Strike

A STRIKE broke out at some of the Iraq Petroleum Company works late in February when 130 labourers employed in the automobile repair section, stores and the power house, walked out. Three-hundred-and-twenty labourers in other sections of the works joined the strike. It is said that dissatisfaction among the workers arose out of a decision of the company or contractor to reduce wages.

The loading of crude petroleum at Haifa has been interrupted as a result of the decision of the strike committee to call out the pump-station hands and other personnel.

The reason for the reduction in wages

appears to be that the I.P.C. finds itself obliged to scale down salaries to a level conforming to the actual operating costs, as opposed to the previous level of construction costs. The decreases, therefore, were part of the measures taken to adjust the operating budget on a permanent basis.

It is understood that certain of the workers demands have been met. These include an eight-hour working day, seven days annual leave, fifteen days annual sick leave, prior notice of seven days for dismissals, and dismissal by departmental managers only and not by foremen.

Late in the evening of March 10 quarters close to the I.P.C. stated: "After an almost continuous meeting for the last forty-eight hours, a settlement has been reached in the Iraq Petroleum Company strike, and work is being resumed.

The company maintained its position on all points of principle but in details has conceded requests of employees where they were thought to be in the interests of all concerned. The settlement was considerably assisted by the efforts of Fakhri Bey Nashashibi. A proclamation has been issued by the strike committee announcing the terms of settlement, calling on the workers to resume, and stating that the settlement secures for them the major portion of their demands. In the proclamation, the Committee expresses thanks to the company for their generous and considerate spirit and for the good faith which has been shown throughout.

The strike committee hopes that the relations between the company and the workers will continue to be as sound and cordial in the future as they have been in the past.

▼

Legal Aspects of Compulsory Unit Operation

Much of the Recent Overproduction and Waste of U. S. Oil Resources Has Been Due to the Antiquated Rule of Capture Which Could be Eliminated by State Laws

By LeRoy H. Hines*

Assistant Legal Advisor
Department of the Interior

THE LAW of oil and gas in the United States, as it has been developed through growth during the second half of the last century and the first part of this century is decidedly peculiar unto itself. This peculiarity is not the result of different legal reasoning in deciding controversies involving oil and gas but is primarily due to inclination of courts in the earlier days of the industry to draw analogies of these substances with other physical subject matter which they considered to be similar in character. In deciding controversies which were presented to them the courts turned to the common law and compared these newly exploited substances with other physical substances whose legal status had been determined.

Because of the fugacious character of oil and gas the courts of Pennsylvania first classified them as minerals *ferae naturae*.[1]

These comparisons and analogies by the courts resulted in the rule of capture in American oil and gas law.[2] This rule of capture, as now firmly entrenched in oil and gas law, is aptly stated by the United States Supreme Court in Brown v. Spillman as follows:

> "Petroleum gas and oil are substances of a peculiar character, and decisions in ordinary cases of mining, for coal and other minerals which have a fixed situs, can not be applied to contracts concerning them without some qualifications. They belong to the owner of the land and are part of it, so long as they are on it or in it, or subject to his control, but when they escape and go into other land, or come under another's control, the title of the former owner is gone. If an adjoining owner drills his own land and taps a deposit of oil or gas, extending under his neighbor's field, so that it comes into his well, it becomes his property."

Under this rule of capture, which means that if a man shall drill a well on his own land, his neighbor has no remedy but to do likewise if he would protect his interests, the development of productive oil and gas acreage divided into small estates has proceeded with undue rapidity. As a result of this rule, the legal unit of development has been the individual lease or tract, rather than the natural and proper unit, which is the pool or field. In a pool divided among many competing operators holding separate leases a drilling stampede ensues—each operator endeavoring to reach the productive formation ahead of his neighbors and to produce at maximum capacity in order not only to prevent drainage from his tract to others but to induce drainage from other tracts to his. Questionable operating practices in developing oil and gas pools and fields have resulted. Notable among these practices is directional drilling, which may bring out some of the most undesirable traits of the rule of capture. If this drilling practice is confined to legitimate ends, there need be no great concern. However, should unscrupulous operators so desire, they may cause no end of grief by directing their wells under the lands of a neighboring land holder, thereby draining his lands by reason of their trespass. Although it is extremely probable that an action of trespass would lie, these unscrupulous operators may well argue that the rule of capture applies and that under this rule they are entitled to drain the common pool.

The fundamental and basic problem of the producing branch of the petroleum industry today is to effect its release from the legal rule of capture. The difficulty lies, however, in finding a suitable remedy or substitute for the rule in view of its entrenchment in the law and the effect any change would have upon vested property rights. Direct legislative action or sweep-

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[1] Westmoreland & Cambria Gas Co. v. De Witt: 130 Pa. St. 333, 18 Atl. 724; Barnard v. Monongahela Nat. Gas Co.: 216 Pa. St. 362, 65 Atl. 801.

[2] Frazier v. Brown, 12 Ohio St. 294

ing court decisions repealing the legal theory of oil and gas ownership may be confiscatory of private property. Thus it can be seen that a repeal of the rule of capture, either by legislation or court decision goes to the root of oil and gas law and is a very serious matter. Although some courts have assertedly repudiated this law of capture,[3] their action has been of little value because they have failed to carry the precedents through to their logical conclusions. This is partially due to the failure of the legislatures to make provisions necessary to enable the owner of oil and gas properties to enjoy reasonably that which he is supposed to own. Custom and habit in the industry also are important contributing factors.

Economic reasons clearly indicate that the fundamental conception of oil and gas law should be changed to concede to each landowner only the oil naturally in place under his land, to relieve him of his liability to loss by reason of drainage from his property and prevent exercise of his present liberty to drain oil from his neighbor's land. Not only should the theory be changed, but the change should be supported by any necessary legislative action. Division of the surface rights of an oil or gas field or pool into small tracts held by various owners causes a ceaseless competitive struggle between adjoining landowners in the area unless they agree among themselves to develop and operate their lands under a cooperative arrangement or unless this is compelled by legislative action.

The ineffectiveness of the common law as an instrument for protecting what would ordinarily be interpreted as property rights in oil and gas has been amply demonstrated. Although the single oil or gas pool or field is the natural unit of property, the courts have adopted the unit of surface ownership of land under which a pool is situated as the legal unit of access to the pool. By analogies to wild game they have held that whatever one having the legal right of access is able to withdraw from the pool through exercise of that right he could take and keep. To protect the value of their legal rights all landowners must proceed to exercise them wherever any one landowner taps the pool. If such rights are exercised individually an orgy of competitive drilling and production results until the pool is depleted.

Although the rule of capture may not be easily repealed by legislative action or overruled by court decision because of the effect it would have upon vested property rights, it appears that there is still another method which is worthy of consideration. That method is cooperative or unit development and operation.

Cooperative or unit development and operation of separate oil and gas fields or pools is a logical and sane basis of development and operation. Under this system competitive drilling on individually owned tracts is reduced to a minimum by removal of the necessity for offset wells to prevent drainage.

It is not to be seriously contended that unit or cooperative operation is a cure-all for all the evils of the capture rule. However, this system of development and operation will go far toward counteracting many of the existent evils of that rule. This point has been amply demonstrated by the plans which are now in effect in many oil and gas fields.

In its generally accepted meaning, unit operation is the practice of consolidating or unifying the ownership or control of an actual or prospective oil or gas pool, field or area so that it may be developed and operated as one property for the benefit of all interested parties.[4]

Unitization does not have the legal effect of actually repealing the well-established rule of capture. By means of a mutual contract or agreement among themselves, however, the parties to the agreement may provide, in effect, that in so far as the development and operation of their lands is concerned, the rule of capture shall have no application so long as this agreement is effective.

By contract and mutual consent of the landowners holding surface rights to the pool these parties merely adopt the pool, for operating and development purposes, as the natural unit of property rather than the unit of surface ownership. This is accomplished by pooling diversified rights of access through surface ownership and substituting definite proportionate undivided interests in the pool for indefinite rights of acquisition and exploitation. Thus those interested merely agree to ignore the capture theory for development and operating purposes. Such a system of development and operation does not have any legislative effect, but as to the lands involved, merely renders the rule of capture inapplicable. If the particular agreement is otherwise valid, there is no legal objection to circumventing the ancient capture rule in this way. Although it is a somewhat indirect method of accomplishing the desired result, it is nevertheless as effective, as to the lands included in the agreement, as though the rule had been repealed by an appropriate legislative body or overruled by court decision. An agreement of this nature would, however, affect only the lands included, and could have no legal effect on adjacent lands not so included.

The accomplishments to the present time under unitization in substituting the natural unit for the surface ownership unit have been substantial yet they are infinitesimal when the proportion of unitized pools is compared with those not unitized. The effectiveness of combating the rule of capture under the unit or cooperative system as applied to any one pool or field depends principally upon whether all productive lands or only a part of such lands are unitized. Naturally, if only a part of the lands are included in the plan the capture rule can be subverted only in part, because the rule is still in effect as to the lands not included, and even then offsets to productive wells on excluded lands still are necessary. The question in relation to the individual pool or field therefore resolves into a question of the degree of unitization. The desirability of including all lands in the agreement thus presents itself forcefully. Taking pools and fields collectively, the question resolves into whether those owning or controlling surface rights desire to enter into such an arrangement and the extent of the unitization in each case. Compulsory unitization appears to be the logical answer to the question of overcoming the evils of the rule of capture.

The states, under their police power, have authority to regulate and prescribe methods for the extraction of oil and gas from a common pool, and may compel unitization on either of two bases—(1) to protect the public interest against waste of the products and (2) to insure a just distribution among the collective owners.[5] The police powers of the state extend to the conservation of its natural resources.[6] Under these powers the state legislature may regulate and restrict the use and enjoyment by landowners of the natural resources of the state, such as oil, so as to protect them from waste and prevent the infringement of the rights of others. Such legislation does not infringe the constitutional prohibitions against taking of property without due process of law, denial of the equal protection of the laws, or taking property without just compensation.[7]

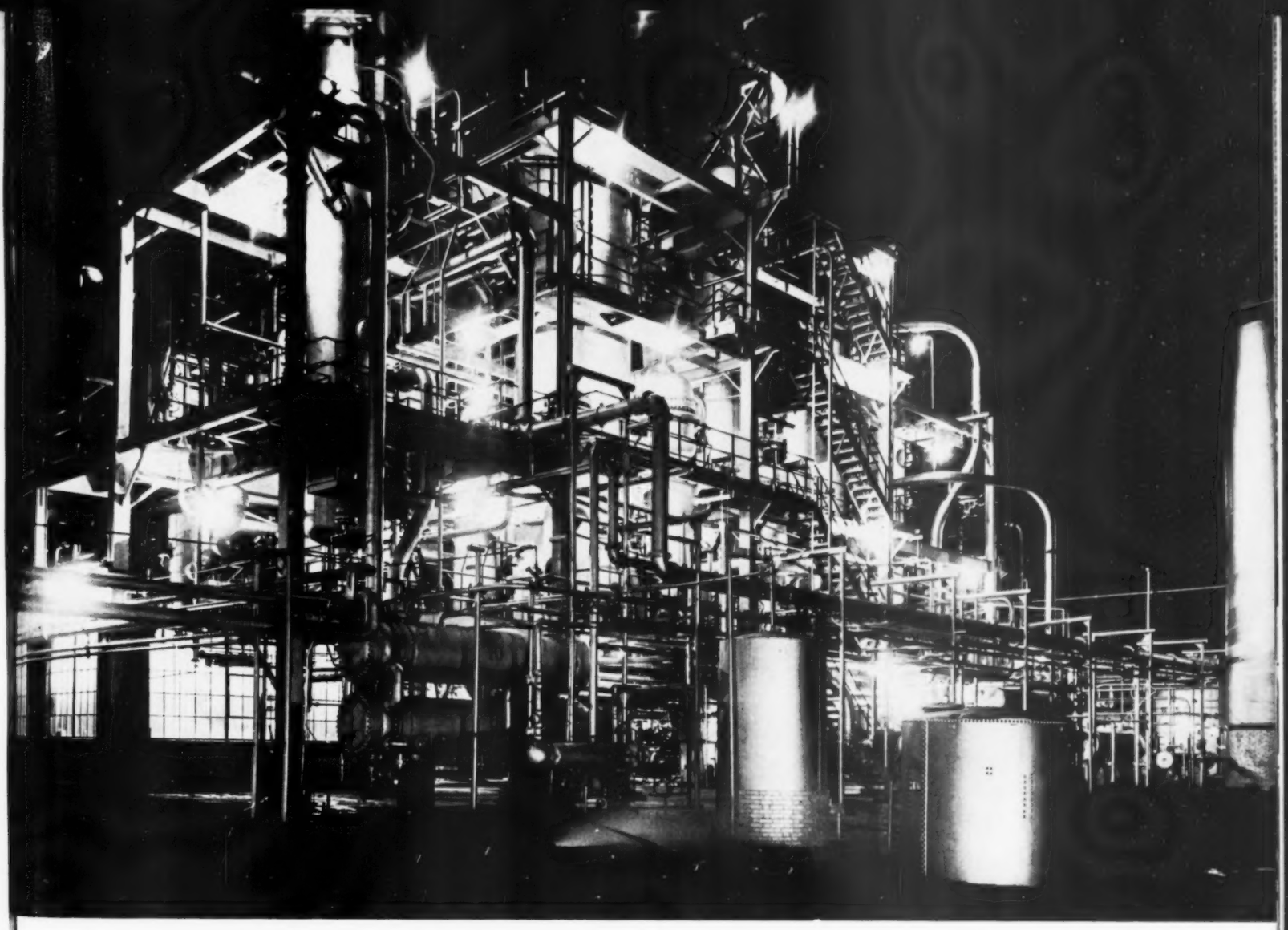
[3] Hall v. Reed, 15 B Mont. 470; United North & South Oil Co. v. Meredith (Tex. Civ. App.) 258 S.W. 550; Swayne v. Lone Acre Oil Co. 98 Tex. 597.

[4] Some Aspects of Unit Operation of Oil and Gas Pools and Fields, LeRoy H. Hines, 1934, p. 8.

[5] Ohio Oil Co. v. Indiana: 177 U. S. 190; People v. Associated Oil Co.; 211 Calif. 93, 294 Pac. 717; Peterson v. Grayce Oil Co; Tex. Civ. App., 37 S.W. (2d) 367, and cases cited therein; Marrs et al v. City of Oxford (1929), 32 Fed. (2d) 1934.

[6] Quinton Relief Oil & Gas Co. v. Corporation Commission: 101 Okla. 164, 224 Pac. 156.

[7] C. C. Julian Oil & Royalties Co. v. Capshaw: 145 Okla. 237, 292, Pac. 841; Champlin Refining Co. v. Corporation Commission of Oklahoma: 286 U. S. 210, 52 Sup. Ct. 559.



Night view of Magnolia Petroleum Company's Duo-Sol plant at Beaumont, Texas.

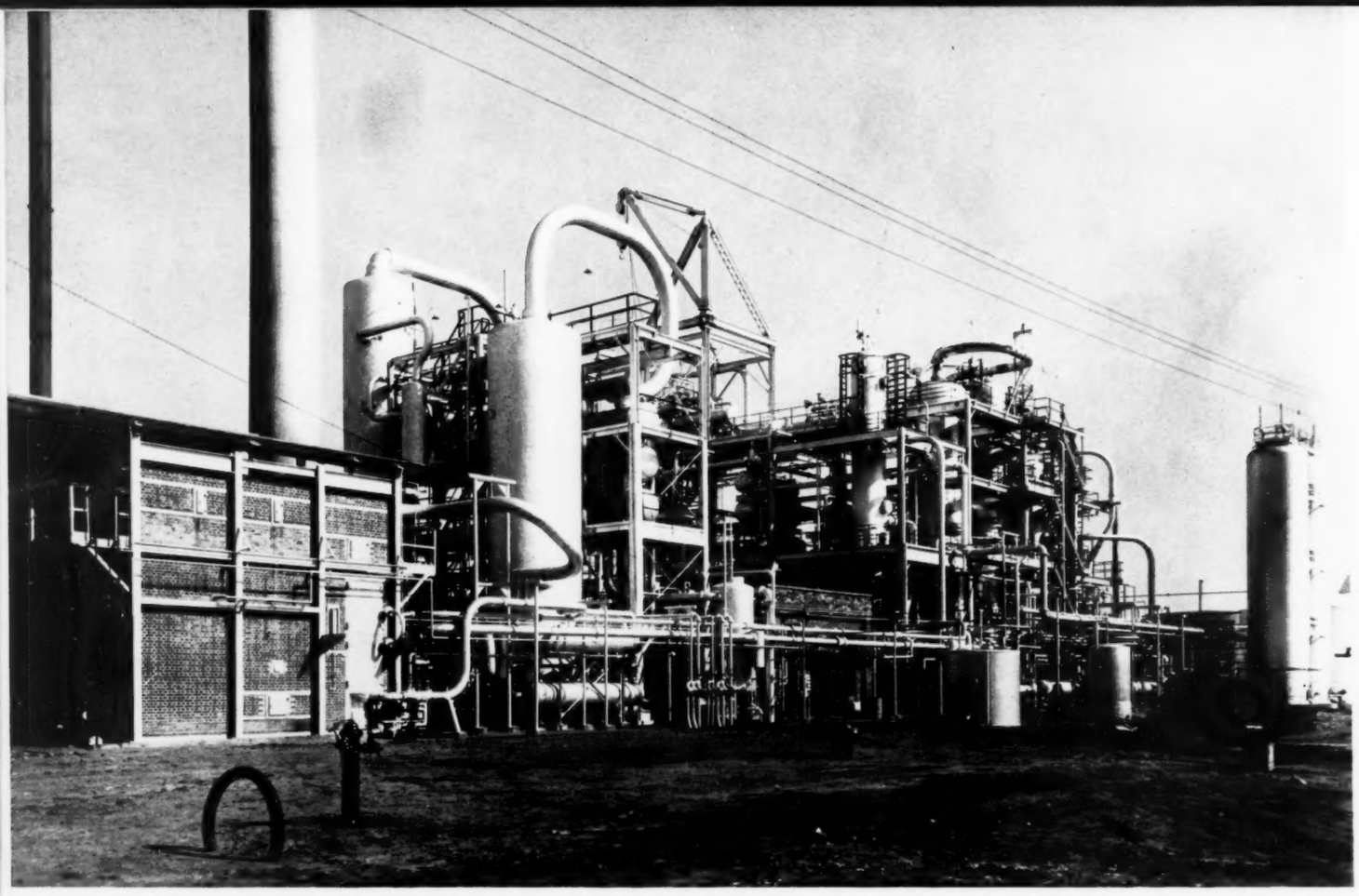
Effect of Duo-Sol in Correcting Oversupply of Bright Stocks

The Theory and Practice of Refining Heavy Stocks to High Quality Lubricating Oil By Means of the Duo-Sol Process — Three Plants on Stream.

By Max B. Miller

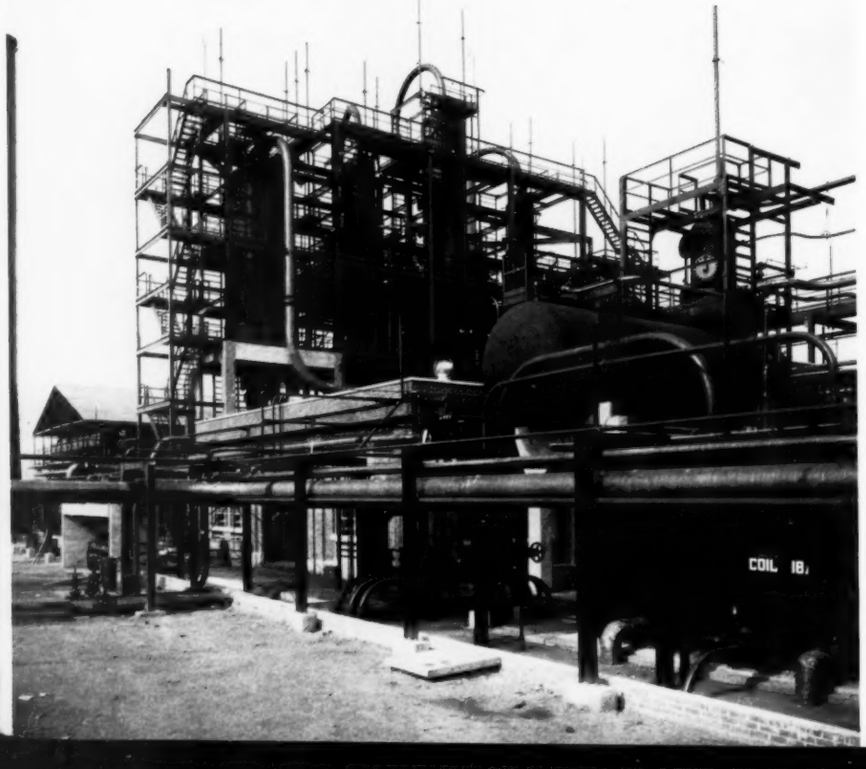
DISREGARDING the preliminary laboratory investigation, it may be said that the Duo-Sol process of solvent extraction first came into being only two years ago this last March when the pilot plant was put into successful operation in Long Island City, New York. Since that time the pilot plant has been on continuous stream. Some seventy-five different stocks suitable for lubricant manufacture have been treated. In the same period three large commercial plants with an aggregate charging capacity of 8,500 bbl. daily have been put into successful operation. Five other commercial plants are at the moment in process of design or construction, one in the United States, the other four in Europe.

As a result of these developments considerable data have been collected with relation to the effectiveness of the process and also the characteristics of the finished product which it is capable of producing. It is the purpose here, therefore, to recite some of the unusual results that have been secured.



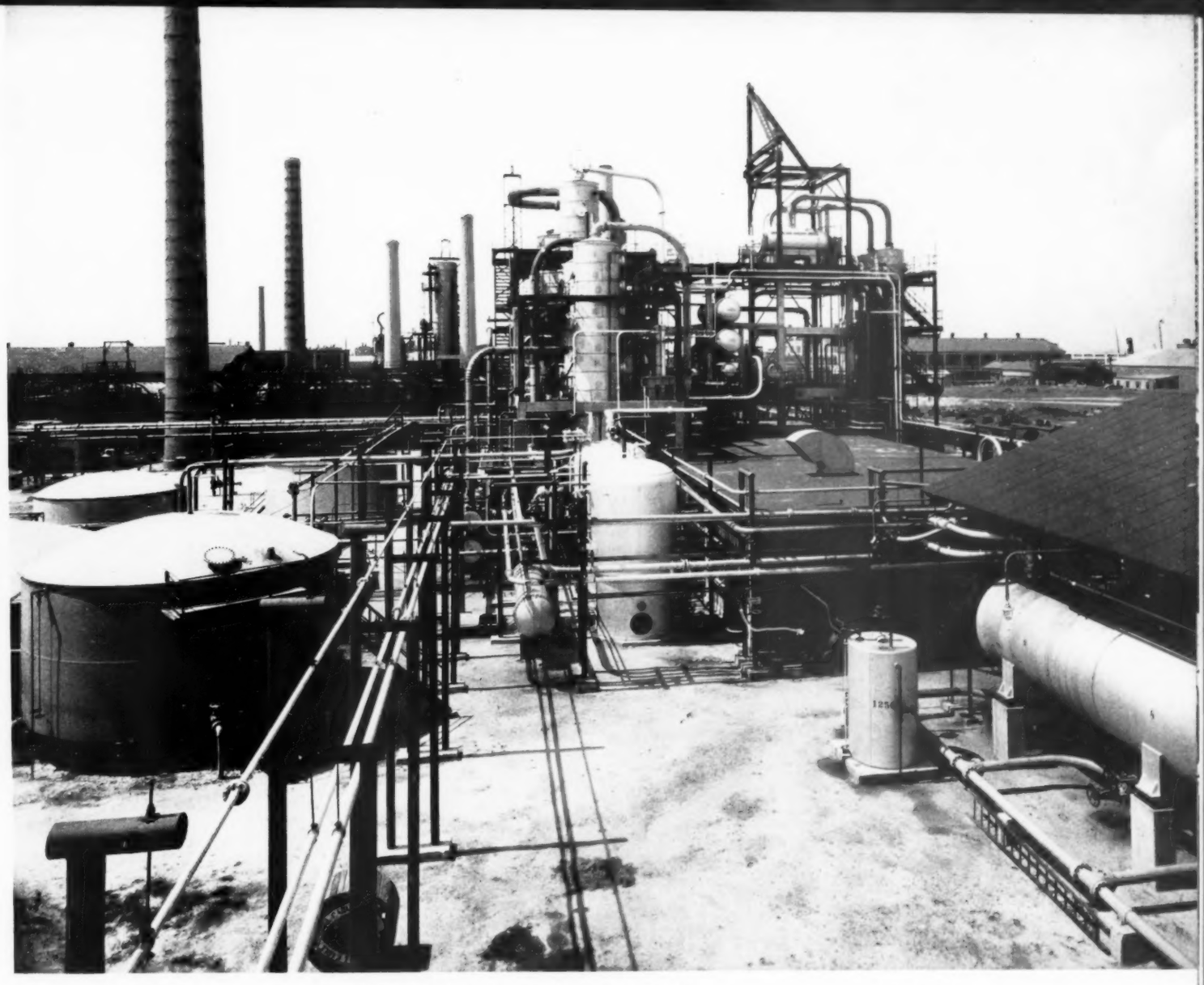
Duo-Sol plant in operation at the Beaumont, Texas refinery of the Magnolia Petroleum Company.

Duo-Sol plant in operation at the Philadelphia, Pa. refinery of the Gulf Refining Company.



Before presenting this data, however, a word might be said with regard to the theory upon which the Duo-Sol process was developed.

The elementary function of the Duo-Sol process is to separate the charge oil into a paraffinic oil (lubricating oil stock) and a naphthenic oil (tar) by means of the use of solvents which will dissolve these two constituents. Early in the development of the process it was found that the best results could not be secured unless the separation was sharply made. It was necessary that the paraffinic oil should be as free of the naphthenic oil as possible and that the naphthenic oil should contain as little lubricating oil as possible. Furthermore, it was found that the use of a single solvent which would dissolve the naphthenic oil or tar failed to secure the desired result for a peculiar reason. After any solvent which is selective for the naphthenic oil dissolves a certain amount of naphthenic oil the solution of naphthenic solvent and naphthenic oil then becomes a solvent for paraffinic oil. In consequence, since the paraffinic oil is dissolved in the naphthenic oil-naphthenic solvent solution, the operation was found to be accompanied by a sacrifice in the yield of the paraffinic oil. Likewise, it was found that if a single paraffinic solvent were used the solution of the paraffinic solvent and the paraffinic oil became a solvent for the



Duo-Sol plant in operation at the Paulsboro, New Jersey refinery of Socony-Vacuum Oil Company.

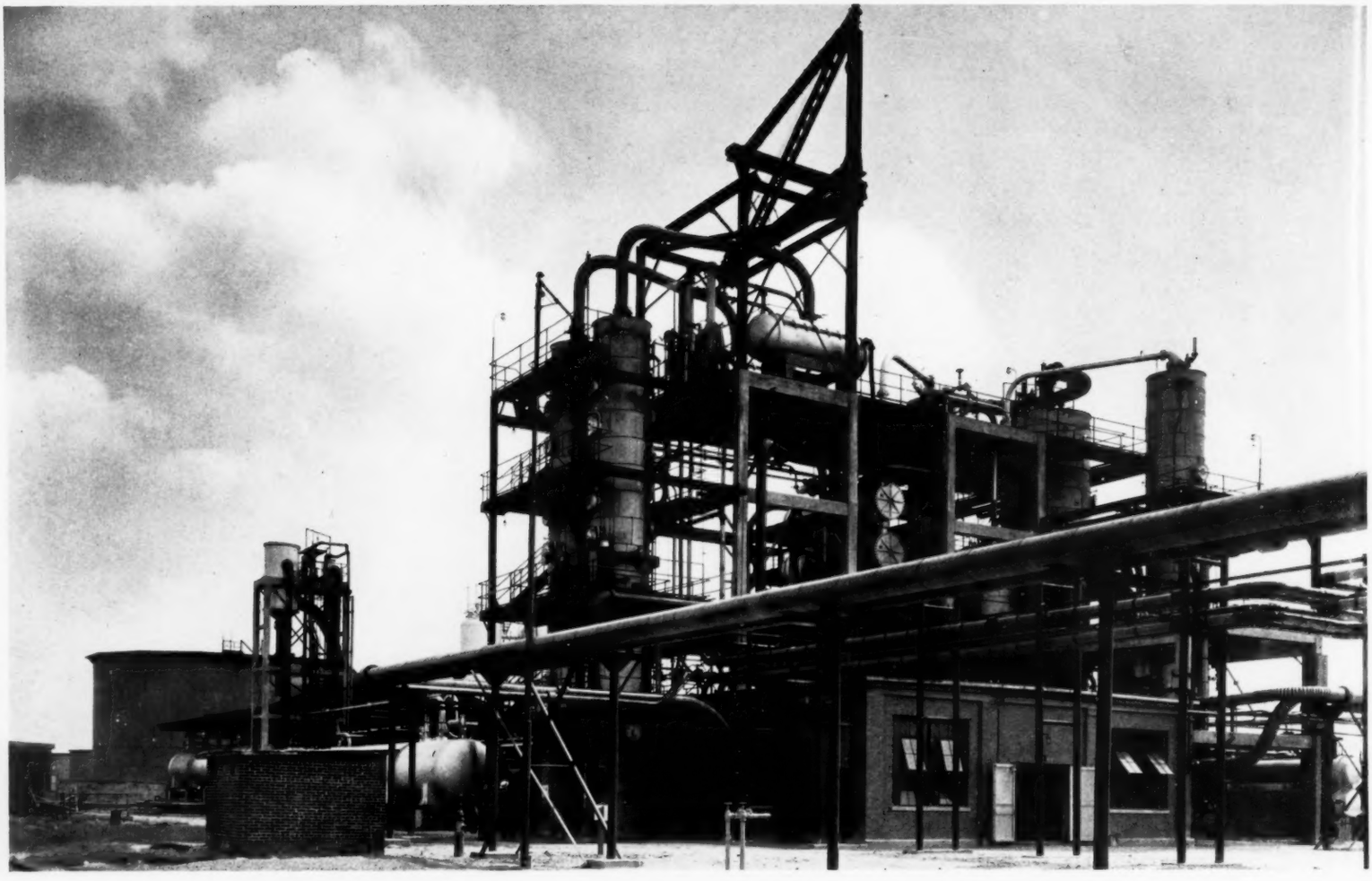
naphthenic oil, and in consequence, the operation was accompanied by a sacrifice in the quality of the paraffinic oil produced.

It was the discovery of these facts which was responsible for the development of the Duo-Sol process. It was seen that if the paraffinic oil was to be recovered from the naphthenic solvent-naphthenic oil solution, the solution would have to be washed with a solvent in which the paraffinic oil would be dissolved. Likewise, it was seen that if the naphthenic constituents were to be extracted from the paraffinic solvent-paraffinic oil solution, the solution would have to be washed with a naphthenic solvent. The final development of the Duo-Sol process was built about this principle. The manner in which it operates may be briefly described as follows:

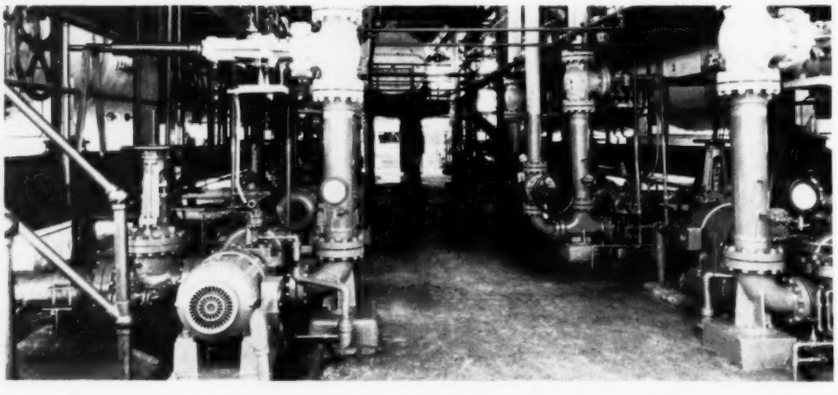
The charge-oil is fed to the center, the paraffinic solvent is fed to the bottom and the naphthenic solvent is fed to the top of the extraction system. In operation the paraffinic solvent flows from the bottom towards the top of the extraction system. The naphthenic solvent flows countercurrently to the paraffinic solvent from the top to the bottom of the extraction system. The crude charge as introduced into the center of the system is immediately separated into two constituents, one of which is more paraffinic than the other. The more naphthenic constituent flows from the center of the extraction system continuously towards the bottom of the extraction system. The paraffinic constituents flow from the center of the extraction system towards the top of the system. In consequence the paraffinic solvent is continuously stripping the paraffinic oil from the more naphthenic constituent of the crude. Likewise, the naphthenic solvent is continually washing the naphthenic content from the more paraffinic constituent of the crude. Thus, as the paraffinic oil is taken from the top of the extraction system, it is free of naphthenic constituents. Thus, as the naphthenic fraction of the crude is taken from the bottom of the extraction system it is free of the paraffinic fractions or the good lubricating oil.

Though carried on in the liquid phase the operation of the Duo-Sol extraction system may be likened to that of a modern fractionating column. The naphthenic solvent performs the services of a reflux whereas the paraffinic solvent takes the theoretical function of stripping steam.

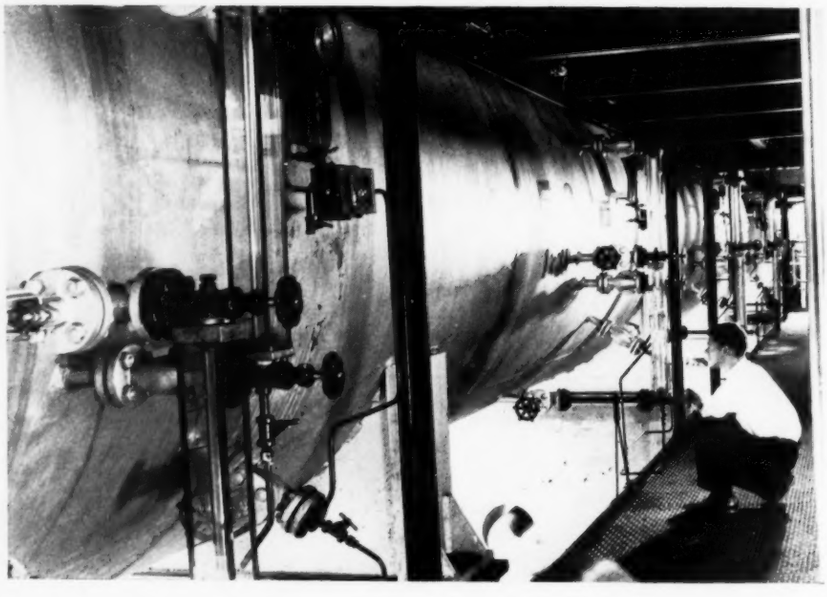
It is this method of operation which is unique to the Duo-Sol process alone and if the analogy may be made again as in the case of the fractionating column, it is the countercurrent flow of the two reagents which permits the sharp separation and which in turn affords the production of the finest lubricants without an uneconomic sacrifice in yield.



Another view of Socony-Vacuum Paulsboro plant.



Extractor transfer pumps in the Duo-Sol plant at Paulsboro.



Extractor control platform at the Socony-Vacuum Paulsboro plant.

ONE of the most interesting results secured at the pilot plant came from the treatment of a heavy Pennsylvania steam refined stock. The raw material as charged to the pilot plant stood at a flash of 560 deg. F., had a viscosity of 165 seconds Saybolt at 210 deg. F., and a carbon residue of 2.6. The paraffinic oil produced from the stock was dewaxed to a zero cold test. The dewaxed oil had a viscosity of 126.5 seconds Saybolt at 210 deg. F., a viscosity index of 106 and a carbon residue of .68.

The interesting thing about this test does not, however, come from the examination of the finished oil. The original charging stock was an oil of high viscosity index. An oil of still higher viscosity index and of lower carbon residue could have been produced from this stock if desired. The interesting part of the test comes from an examination of the extract or the tar which was separated from the oil. It was a black asphaltic material which was solid at normal temperatures. Its specific gravity was 1.06. Its Furol viscosity at 210 deg. F. was above 2,000 seconds. The physical tests of the material were not necessary to determine the fact that it had no place in a high quality

lubricant. One look at it would tell one that.

WHEREAS the above tests indicate what the Duo-Sol Process would do when handling stocks of high quality, the treatment of a residuum made from the reduction of Iraq residuum clearly shows what might be accomplished by the Duo-Sol Process in producing a high grade lubricant from a charging stock which has heretofore been considered as unsuitable for the purpose.

Characteristics of Iraq Charging Stock

Flash	420
Fire	470
Gravity	14.8
Specific Gravity	.9672
Viscosity Gravity Constant	.899
Sulphur Content	4.03

In the pilot plant treatment of this material the operation was divided into three tests in which different solvent rates were utilized in each case. The accompanying table shows the characteristics of the paraffinic oil produced before dewaxing, the specific gravity of the separated tar, the yield of paraffinic oil with relation to the charge, the solvent rates, and the characteristics of the oil after dewaxing for each of the three methods of treatment.

Results of Three Test Runs

	Run 61-A	Run 61-B	Run 61-C
Solvent rates:			
Selecto	400%	300%	125%
Propane	300%	400%	400%

Characteristics of Paraffinic Oil Before Dewaxing

Gravity	30.8	29.1	25.7
Specific Gravity	.8718	.8811	.9001
Vis. at 210	50.5	53	59
V.G.C.	.8025	.8130	.834
Color N.P.A. Scale	4	3½	4
Specific Gravity of Tar	1.060	1.073	1.104
Percent of paraffinic oil before dewaxing	49.3	55	67.2
Sulphur Content of Tar	....	6.71	....

Characteristics of Dewaxed Oil

	Run 61-A	Run 61-B	Run 61-C
Gravity	29.2	27.6	24.0
Vis. at 100	279	324	511
" " 210	52	54.2	63
Pour	Plus 5	Plus 5	Plus 5
V.G.C.	.813	.822	.846
V.I.	104	100	92
Carbon Residue	.12	.17	.46
Sulphur Content	....	Trace	....

There are two points in connection with the above tests which are deserving of special interest. We refer to the color of the oil as discharged from the Duo-Sol plant. The colors indicated were the result of only Duo-Sol treatment, no acid or decolorizing clay was used in producing the colors secured. It should also be noted that whereas the charging stock contained a goodly percentage of sulphur, the paraffinic oil showed only a trace of sulphur or, in other words, an unmeasurable amount. In fact, this test would indicate that the Duo-Sol treatment of stocks containing sulphur will produce a finished lubricant as free of sulphur as

Interior view of Duo-Sol pilot plant erected by Max B. Miller and Company at Long Island City, N. Y. prior to the commercial establishment of the process.

that obtained from crudes which are normally considered to be sulphur free.

THE recent increased demand for lighter motor lubricants has thrown the lubricant manufacturer out of balance with his markets, that is, in the United States at least, there is today too much bright stock and there is not enough neutral. Two years ago if one were to average the viscosity in seconds Saybolt at 210 deg. F. of each grade of motor oil on the basis of the percentage in which each grade was consumed by the market, one would have found that the mean viscosity of the full line of oils would have ranged from 70 to 75 seconds Saybolt at 210 deg. F. Because of the increased demand for the lighter motor oils, the mean viscosity of the motor oils required by the market today will range from 60 to 65 seconds.

If one were to take any residual oil from any source, if they were to consider that that residuum when standing at a flash of 440 deg. F. contained substantially all of the motor oils there were in the crude, if they were to refine that residuum by conventional practice, the finished oil would have a viscosity of from 85 to 90 seconds Saybolt at 210 deg. F. or, in other words, would contain too much bright stock and not enough neutral. On the other hand, if that same residuum were to be refined by the Duo-Sol Process, because the process separates from the charging stock a tar composed of very highly viscous naphthenic and asphaltic material, the viscosity of the finished oil produced would range from 60 to 65 seconds Saybolt at 210 deg. F. which would give the manufacturer an oil in which there would be no deficiency and no oversupply of either neutral or bright stock.

It is an interesting fact that upon reviewing the results secured by the Duo-Sol Process almost irrespective of crude supply the flash point or, better yet, the initial boiling point of the residuum to be treated is the only factor controlling the viscosity of the finished dewaxed oil produced which will vary only with the degree to which the oil is refined by the Duo-Sol Process. In consequence, it can be said that whether the future calls for oils of higher or lower mean viscosity in comparison with today's market demand, the Duo-Sol Process will have the ability to produce from the long residuum a single stock which when subsequently fractionated and reblended will be in perfect balance with the market of the day.

DURING the past few years it has been generally considered that a modern vacuum distillation unit was capable of producing overhead stocks free from asphaltic material without injury to the lubricating characteristics of the resulting finished product.

As a matter of academic interest a vacuum still bottom made from the reduction of a Mid-Continent crude was treated in the laboratory by the Duo-Sol Process. The still bottom as charged to the Duo-Sol Process had a specific gravity of .9957 and a Furol viscosity at 210 deg. F. of 1375. As a result of the Duo-Sol treatment of the still bottom a tar was produced which had a specific gravity of 1.06. A paraffinic oil representing 45.8 percent of the vacuum still bottom was produced. It was substantially wax-free and it had a viscosity of 710 seconds Saybolt at 210 deg. F. Because of the high viscosity of the material it was practically impossible to determine its viscosity index as such. It was consequently blended with an S.A.E. 30 oil which had been made from the same crude which had a viscosity index of 100. The blend was made on the basis of 75 percent S.A.E. 30 oil and 25 percent of the heavy oil.

The results were as indicated in the accompanying table.

Characteristics of the Blended Material

Gravity	27.1
Viscosity at 210	109
Viscosity at 100	1312
V.I.	103
Pour	Plus 5

The above test is one of several similar tests that have been made. They indicate that no matter how far one may go in producing lubricants overhead by vacuum distillation, the bottom will contain a goodly percentage of lubricating oil the paraffinicity of which would seem to be higher than that secured either as a result of the treatment of the long residuum or the overhead product if made from the same crude.

BECAUSE of the universal interest in lubricants which have been refined to a high degree, most of the data which we have published in the past concerning the Duo-Sol Process has had to do with the manufacture of high grade oils. For this reason the fact that the Duo-Sol Process is an economic tool which may be used for the production of oils having characteristics prevalent in those secured by past practices seems to have been lost sight of. The ability of the process in this connection can best be illustrated by the results secured from the treatment of a coastal lubricating distillate and a Mid-Continent pipeline residuum in which the only object was to eliminate acid treatment, caustic neutralization, and to curtail the cost of filtering the oil to final color.

THE COASTAL lubricating oil distillate had a gravity of 18.8, a viscosity of 51 seconds Saybolt at 210 deg. F. and a color of 7¼ on the N.P.A. scale.

It was given a light Duo-Sol treatment in which 125 percent Selecto and 250 percent propane were utilized. The extract or tar which was separated from the oil had a specific gravity of 1.06. The yield of lubricant represented 91.3 percent of the charge. It had a 3 color on the N.P.A. scale. The Navy emulsion test of the oil showed a complete break in less than 60 seconds. The oil was, therefore, free of naphthenic acids. It was calculated that the direct cost of the treatment would amount to a fraction of a cent a gallon. As a result the necessity of distilling over caustic, of acid treatment and of subsequent neutralization was completely eliminated.

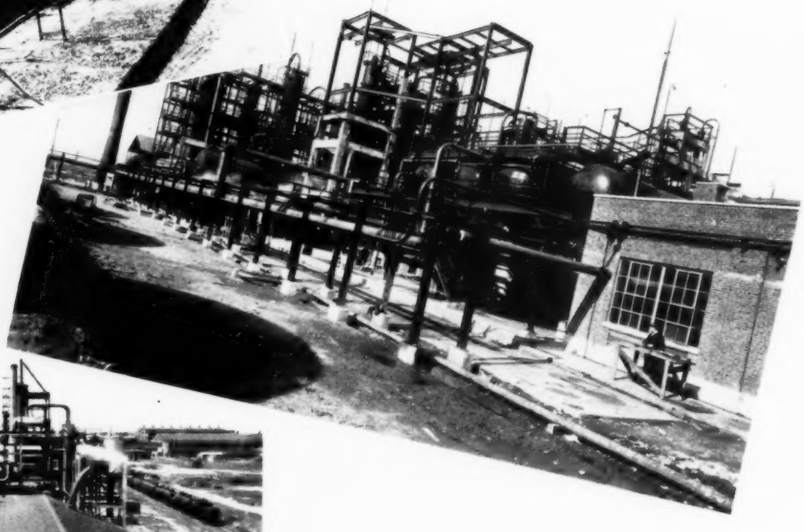
The Mid-Continent pipeline residuum had a gravity of 21.1, a viscosity of 197 seconds Saybolt at 210 deg. F. and a flash of 530. The stock was treated with 125 percent Selecto and 400 percent propane. The tar or extract separated from the oil had a specific gravity of 1.075. The paraffinic oil produced represented 85.8 percent of the original charging stock. After dewaxing, the paraffinic oil had a gravity of 24.5 and a viscosity of 138.5 at 210, a viscosity index of 78.5, color 7½ on the N.P.A. scale, a carbon residue of 1.0.

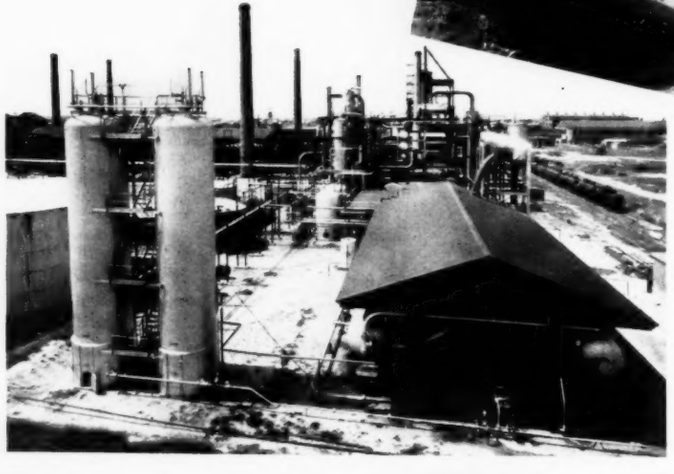
It was calculated that the direct cost of such a treatment would be a fraction of a cent a gallon. Not only did the treatment eliminate the necessity of acid treating and subsequent neutralization but in addition it produced an oil of better color and of lower carbon residue than would be possible in the case of conventional practice.

It should be explained that the Duo-Sol Process of solvent extraction does not synthetically produce lubricants out of a raw material. It merely separates the paraffinic and naphthenic constituents of the charging stock. The yield of paraffinic oil it will produce, the characteristics of the finished product, will depend only upon the characteristics of the stock charged to the process and the degree to which the oil is refined. In order that the reader may have an indication as to the results that might be expected from charging stocks quite divergent in their characteristics we tabulate below the characteristics of twelve different stocks that have been treated by the Duo-Sol Process, giving the characteristics of the charge, the solvent rates used, the characteristics of the separated tar, the yield of the paraffinic oil together with the characteristics of the finished dewaxed product.

OIL SPECIFICATIONS	PENNSYLVANIA CYLINDER STOCK	PENNSYLVANIA LONG RESIDUUM	RANGER BURBANK RESIDUUM	DEEP SAND REAGAN RESIDUUM	IRAQ RESIDUUM	COASTAL NEUTRAL	SAN JOAQUIN DISTILLATE	PANHANDLE OVERHEAD (DEWAXED)	MID CONTINENT STEAM REF. STOCK	KANSAS LONG RESIDUUM	HENDRICKS RESIDUUM	MID CONTINENT NEUTRAL
CHARGING STOCK												
GRAVITY A.P.I.	25.6	28.6	23.5	22.4	14.8	18.8	16.3	22.9	21.1	18.6	16.8	25.4
SPECIFIC GRAVITY	.9007	.8838	.9129	.9194	.9672	.9415	.9574	.9165	.9273	.9427	.9541	.9018
VIS @ 210°F.	165	70	84	205	194	51	96	95	197	154	147	48
FLASH	560	435	450	555	420	350	465	520	530	485	455	430
FIRE	625	465	500	625	470	385	525	585	600	570	500	485
V. G. C.	.8135	.8080	.8480	.8350	.8990	.8945	.8970	.8445	.8465	.8700	.8860	.8520
SOLVENT RATES												
PERCENT SELECTO	400	400	300	325	300	125	800	225	125	400	275	300
PERCENT PROPANE	200	300	350	250	400	250	300	200	400	300	250	150
PARAFFINIC OIL BEFORE DEWAXING												
GRAVITY A.P.I.	28.6	30.9	29.9	28.1	29.1	—	30.8	—	25.2	29.5	27.6	—
SPECIFIC GRAVITY	.8838	.8713	.8767	.8866	.8130	—	.8718	—	.9030	.8789	.8894	—
VIS @ 210°F	122	61.5	61	121.5	53	—	53.6	—	123	66.5	67	—
V. G. C.	.7960	.7950	.8030	.8000	.8811	—	.7990	—	.8210	.8035	.8170	—
COLOR N.P.A. SCALE	70/30 7½	7½	5½	8	3½	3	1¾	4¾	7½	8+	4½	3¾
PERCENT YIELD PARAFFINIC OIL BEFORE DEWAXING WITH RELATION TO CHARGE	88.1	92	78.4	76.9	55	91.3	25.4	79.5	85.8	59.5	49.3	78.3
NAPHTHENIC FRACTION												
SPECIFIC GRAVITY	1.026	1.027	1.045	1.029	1.073	1.060	.9865	1.037	1.075	1.037	1.017	1.015
PERCENT YIELD TAR WITH RELATION TO CHARGE.	11.9	8	21.6	23.1	45	8.7	74.6	20.5	14.2	40.5	50.7	21.7
DEWAXED OIL												
GRAVITY A.P.I.	27.8	30.0	29.0	27.3	27.6	20.6	30.7	28.3	24.5	29.1	27.5	31.1
SPECIFIC GRAVITY	.8883	.8762	.8816	.8911	.8894	.9303	.8724	.8855	.9071	.8811	.8899	.8702
VIS @ 100°F	1625	451	509	1930	324	316	341	667	2700	515	580	178
VIS @ 210°F	126.5	63.5	65	133.2	54.2	47.5	54.5	72.5	138.5	66	67	130/97
POUR	0	5	20	10	5	-5	10	10	10	5	0	5
V. G. C.	.8010	.8010	.8100	.8044	.8220	.8830	.8003	.8085	.8250	.8060	.8170	.8150
V. I.	106	108	100	99.5	100	15	95	97	78.5	103	94	100
CARBON RESIDUE	.68	.38	.23	.446	.17	TRACE	.02	.20	1.0	.20	.15	TRACE

NOTE
COLOR INDICATED IS THAT PRODUCED BY DUO-SOL PROCESSING WITHOUT OTHER TREATMENT.





DUO-SOL

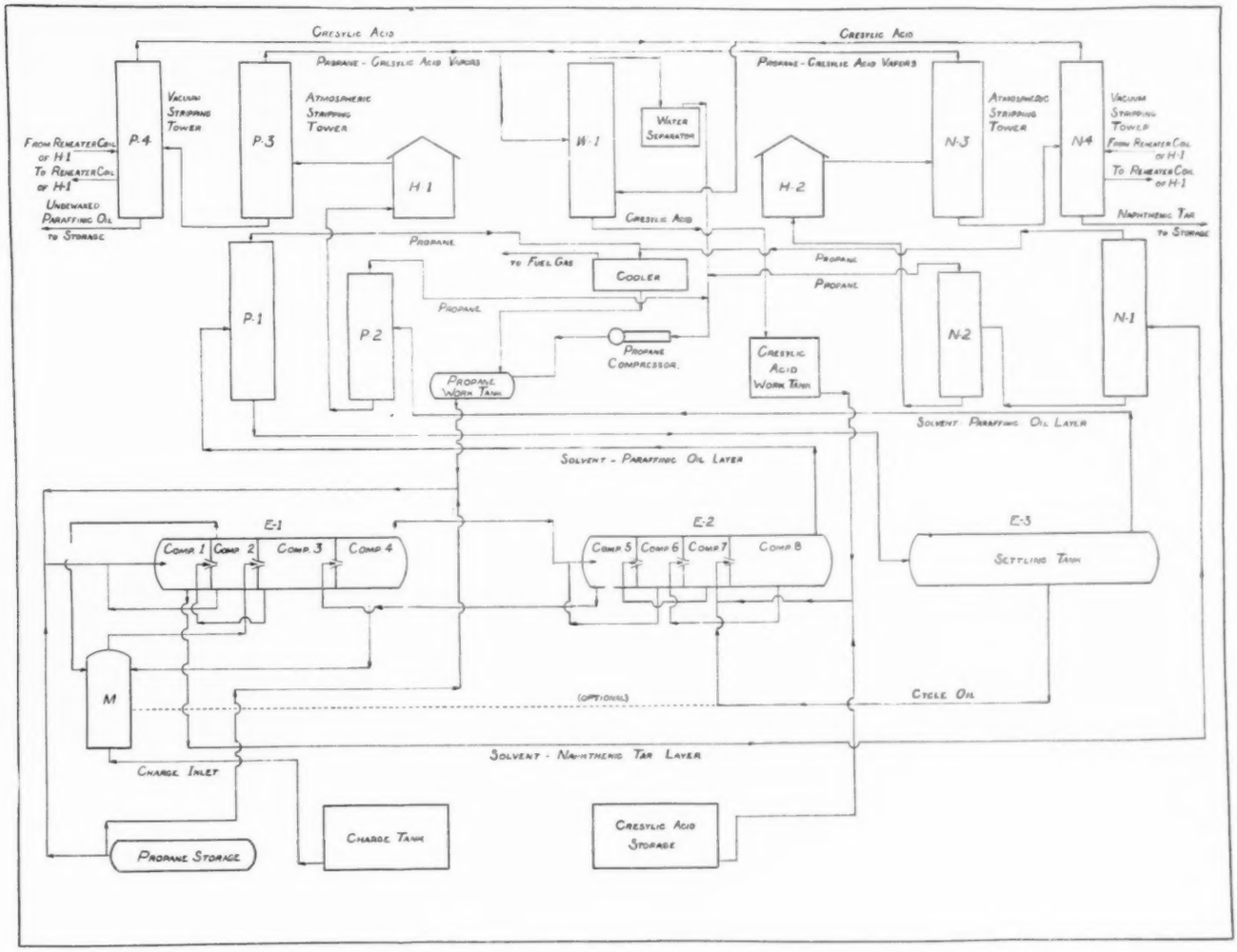
The Duo-Sol Process In Commercial Operation

With the Installation of Three Large Scale Commercial Units Within the Past Year This Lubricant Extraction Method Establishes Itself as Another of the Major Petroleum Refining Processes

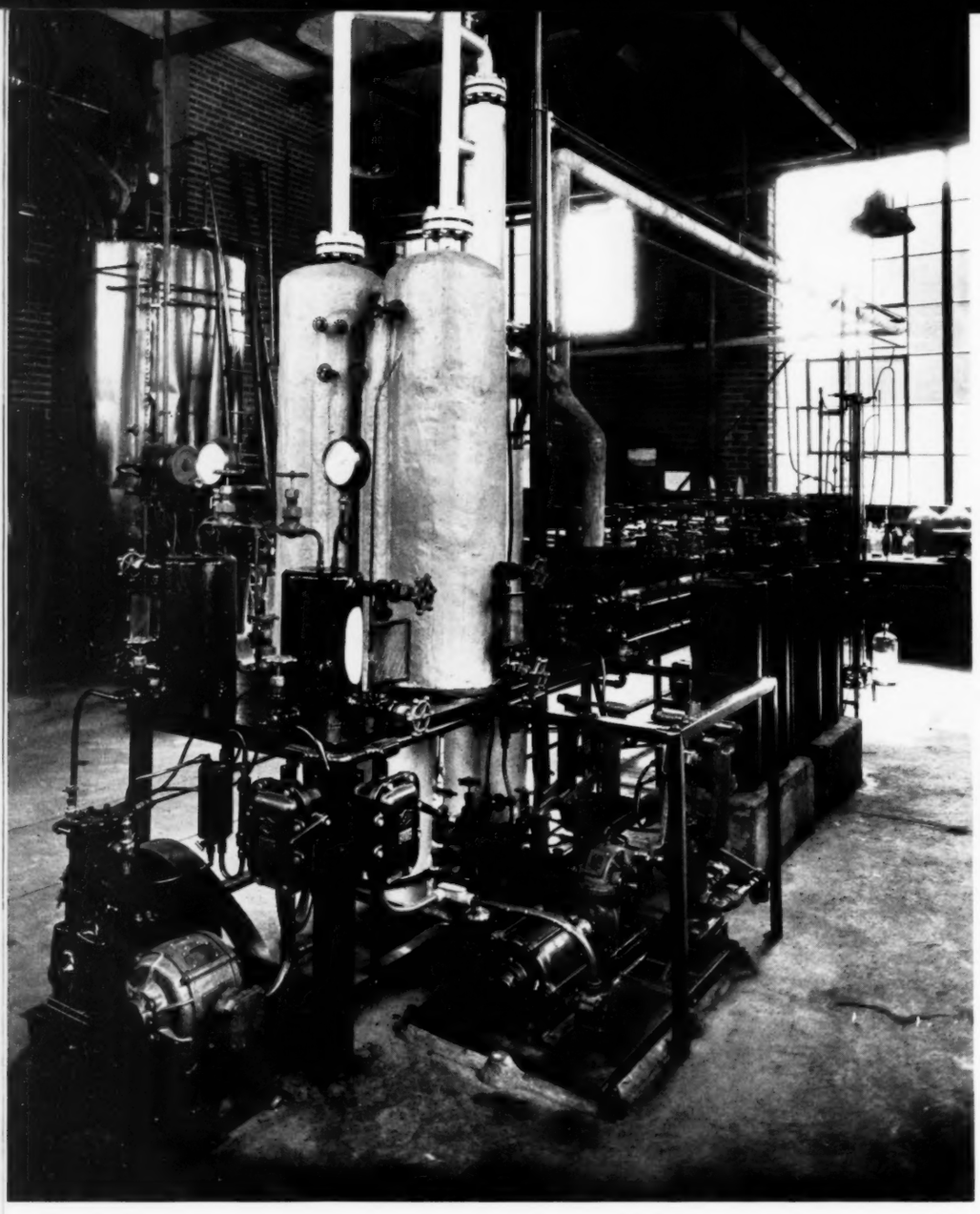
By E. Ospina-Racines

LARGE scale commercial installations of the Duo-Sol Process for lubricant extraction are now in operation in the United States. These units are processing oils in the refineries of the Gulf Refining Company at Philadelphia, Pa.; of the Socony-Vacuum Oil Company Inc. at Paulsboro, N. J.; and of the Magnolia Petroleum Company at Beaumont, Texas.

The most critical step in the development of a petroleum refining process is the one from the pilot plant to the commercial installation inasmuch as the engineering and designing must contend with a greater problem and the test results are greatly magnified. From a three-barrel capacity pilot plant to a combined capacity of 8,500 bbl. per day these commercial installations attest to the inherently correct principles incorporated in the process, to the efficient design embodied in the plants, to the ability of the method to process a variety of charging stocks and produce



Flow chart of the Duo-Sol installation at the Philadelphia plant of the Gulf Refining Company.



Duo-Sol pilot plant installed at the Gulf Refining Company's plant at Philadelphia.

exacting requirements of high quality lubricants, to the efficiency and economy derived from solvent refining of oils and equally important to the recognition and acceptance of this recent noteworthy development in petroleum refining.

The Duo-Sol Process as a physical-chemical method in petroleum refining may be utilized in a unique role. The process may be an agent in extracting the lubricant fractions from low value residual oils or it may be employed as a means of refining the lubricant distillates. Moreover, it may process residual oils otherwise unsuitable for lubricant manufacture by the conventional direct vacuum distillation. In these instances it results in obviating the use of sulfuric acid and its attendant problems of neutralization and emulsification, reduces the filtration requirements to a minimum to attain the desired color and produces high quality stable lubricants able to meet rigid specifications.

So far its principal role has been in the extraction of the paraffinic fractions from residual oils, previous to vacuum distillation, inasmuch as greater benefits and economy are derived by this method.

The process will be briefly outlined to indicate its operating principles. As its name implies, the Duo-Sol Process utilizes two solvents, namely propane and cresylic acid or as it is also designated Selecto. These have a limited solubility in each other but have the properties of dissolving respectively the paraffinic and naphthenic (tarry) constituents of the charging stock. The contacting of these solvents with the charging stock results in a two phase system, the propane solution comprising the valuable lubricant fractions and the cresol or Selecto solution the tarry or deleterious compounds. Following this extraction step, gravity separation of the phases is effected as two layers, due to the Selecto solution possessing a higher specific gravity. Separation of the valuable lubricant fractions from the propane solution and the tarry oil from the Selecto solution will yield the desired product and will also permit the re-use of the solvents and thereby maintain a cycle which is essential to the economical operation of the system. The latter step is carried out by respective distillation of these solutions. The extraction step of the process offers no difficulties since it consists in contacting these liquids at normal temperatures and under pressure sufficient to maintain the propane in liquid phase and promoting their solution. The separation and solvent recovery system is the complicated part of the extraction process.

Although separate distillation systems are required for the recovery of each solvent the benefits gained in effecting a more complete extraction offsets any disadvantage arising from this consideration.

It can be shown theoretically and practically that when propane is used in conjunction with a selective solvent such as Selecto, a greater extraction efficiency and better control of the solution process with benefits of an increased yield and savings in subsequent treatment not only justify but call for a double solvent system.

Referring to the accompanying flow

Control panel for the Gulf's Duo-Sol plant.

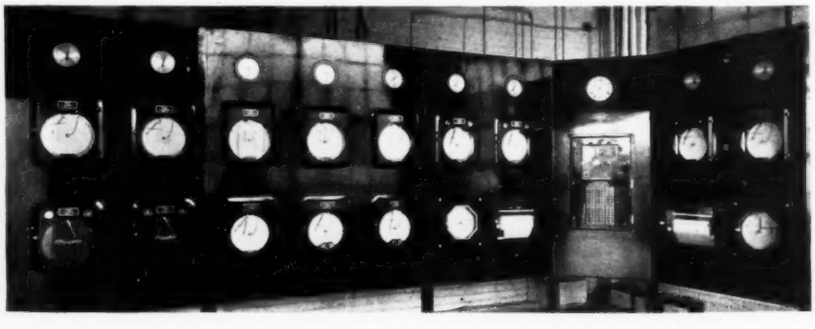


diagram the apparatus and essential operations of the Duo-Sol Process may be outlined. The lower part of the diagram indicates the extraction equipment for contacting the propane and Selecto solvents with the charging stock. This equipment comprises horizontally positioned tanks, internally divided into compartments with individual pumps for each division. These serve to circulate and maintain the flow of the solutions.

The upper portion of the diagram illustrates the distillation equipment for separation of the oils and recovery of the solvents. If the solvents were completely immiscible this part of the process would be greatly simplified. Due, however, to the partial miscibility of the two solvents the propane solution will carry with it a small proportion of the Selecto solvent and the Selecto solution will carry with it some propane solvent. The distillation equipment is therefore interconnected so that a complete separation and recovery of the paraffinic and naphthenic oils and their respective solvents is effected.

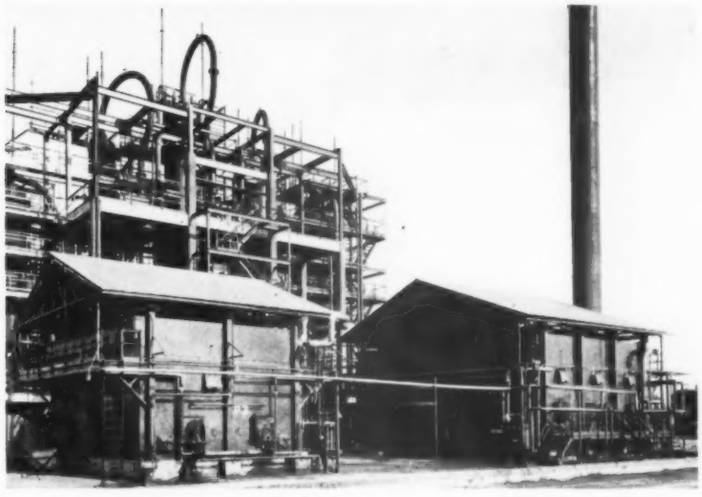
The towers N-1; N-2 and P-1; P-2 receive the extraction solutions initially where most of the propane is flashed overhead at this step. N-1 and P-1 are equipped with steam reboilers which are very effective in realizing this step. The reflux from these towers is further processed in the upper distillation equipment. In one instance the propane solution is treated in the equipment on the left while the Selecto solution is treated primarily in the equipment on the right. The overhead products from these latter operations are the solvents and the refluxes are the separated paraffinic and naphthenic oils respectively.

In order to appreciate the actual operation of the Duo-Sol Process detailed data on its runs and a more definite description of the system is desirable. As was already mentioned, the Duo-Sol Process has been utilized primarily for refining residual oils for recovery of the lubricant fractions. The Paulsboro and Beaumont installations charge reduced Mid-Continent crude and since their charging stocks and operation are alike their yields are very much the same.

Characteristics of Charging Stocks

Plant	Paulsboro-Beaumont
Gravity, A.P.I. degrees	25.5
Specific gravity, 60 F.	0.9013
Flash, F.	470
Viscosity at 210 F.	105
Pour, deg. F.	85
V.G.C.	0.844

In the Beaumont plant 27,200 lbs. per hour, equivalent to 2,030 bbl. per day, is charged. To this amount 88,000 lbs. of propane, representing 325 percent of the charge and 104,000 lbs. of Selecto or 380 percent of the charge, are used.



Two of the furnaces for the Gulf's Duo-Sol plant.

The size of this installation may be appreciated by considering the fact that the combined volumes of the solvents and raw material is equivalent, according to the above proportions, to handling about 16,500 bbl. per day. The proportions of the solvents have a direct effect on the nature of the finished product. As may be expected, increased amounts of propane will improve the color of the paraffinic oil extracted. However, it affects the viscosity index and viscosity-gravity constant adversely and particular adjustment of the proportions of solvents must be made to obtain optimum results.

The following specific description of the flow diagram and process steps will explain the operation details and will suggest the intricate engineering and designing problem that have been solved and the particular equipment that had to be incorporated in order to make these commercial installations function smoothly and efficiently.

The raw material, which is reduced crude, and predetermined proportions of the solvents are contacted within the compartments of the two horizontal extractor tanks. These are 75 and 60 ft. long with compartments ranging from 12 to 25 ft. in length. The propane from the storage and working tanks is introduced in compartment No. 1 and Selecto in No. 8. The raw material is first mixed with Selecto solution from compartment No. 4 and propane solution from No. 2 in tank M and the combined mixture is maintained cool by a low pressure steam vacuum refrigeration unit. The mixture is directed to compartment No. 3.

The horizontal position of the tanks offers large settling areas and as the components dissolve the Selecto solution becomes more naphthenic and of higher specific gravity, thus settling as the lower layer and the paraffinic solution as the upper layer. Individual pumps for each compartment cause the solvents to flow countercurrently, the lower layer being acted upon directly while the upper layer is caused to flow by the drop in pressure occurring between the divisions. This is due to the nozzles located at the discharge of these flow lines. The conditions and nature of the paraffinic solution while in progress may be interpreted from the accompanying data taken from the Beaumont plant. This installation differs from the flow diagram, having nine instead of eight compartments.

Progress of Paraffinic Solution

Compartment	Temperature F.	Gravity A.P.I.	Viscosity 210 F.	V.G.C.
1	85	21.2	108	0.855
2	90	24.5	94	0.832
3	90	25.8	83	0.825
4	90	25.7	89	0.824
5	86	27.1	76	0.817
6	85	28.8	74	0.805
7	83	29.3	74	0.802
8	83	29.8	72	0.799
9	78	29.7	77	0.798

The propane solvent enters in compartment No. 1, the Selecto solvent in No. 8, as noted in the diagram for the Gulf plant or No. 9 in the Beaumont plant. The raw material enters, from the mixer M, in No. 3. The propane solution or solvent paraffinic oil layer issues from compartment No. 8 as noted in the flow diagram. The Selecto solution or solvent naphthenic (tar) layer leaves from compartment No. 1.

Leaving the extractors, these solutions are directed to the oil separation and solvent recovery system. The operations differ from each solution inasmuch as propane is readily vaporized while Selecto has a much higher boiling range. While propane may be taken overhead under pressure, Selecto must be separated under reduced pressure. Moreover, the latter solution contains the heavier constituents of the charging stock and lower temperatures are therefore necessary to avoid thermal decomposition. As may be observed from the flow diagram this equipment is all interconnected since both solutions contain proportions of each solvent.

The naphthenic solution derived from the extractor contains the following percentages by weight: propane, 20 percent;

Selecto, 74 percent; naphthenic (tarry) constituents, 6 percent.

The heat requirements for the oil separation and solvent recovery system are obtained from two gas fired furnaces, H-1 and H-2. These have a double combustion chamber with centrally located common flue convection section and is a design that offers considerable radiant section. H-2 is for vaporizing the naphthenic solution previous to the atmospheric and vacuum distillations and after the initial depropanizing steps. H-1, noted on the left, takes care of the propane solution but its internal piping arrangement takes care also of the Selecto reflux from vacuum tower N-4. In addition to these furnaces, steam reboilers for thermosyphoning, located on towers N-1 and P-1, and also numerous heat exchangers for passing incoming and outgoing oils are used wherever possible, thus reducing the furnace load and adding to the economy of the system.

The towers N-1 and P-1 receive the solutions from extractors E-1 and E-2. The towers N-1 and N-2 depropanize the naphthenic extract and P-1 and P-2 the paraffinic extract. These extracts are first passed through heat exchangers and raised to a maximum temperature of 260 deg. F. then delivered to N-1 and P-1 respectively which are carried under 190 lbs. pressure. This results in 96 percent of the propane removal which is taken overhead and cooled in a common line, condensed and returned to the working tank. The reboilers located on these towers, N-1 and P-1, are thus particularly effective in removing a large percentage of the propane.

The progress of the solutions after this action which is the first of the initial depropanizing steps, continues but through different operations. The progress of the paraffinic solution which results in the separation of the solvent and the valuable lubricating oil will now be followed.

The solution from tower P-1 is returned to the additional extractor E-3 noted below, which acts as an accumulator and permits regulation of the flow to the rest of the system. From the upper layer of this tank, E-3, the paraffinic solution flows through heat exchangers and then to the secondary propane evaporator, P-2 where the pressure is held at about 45 lbs. and additional propane is recovered as an overhead product, which is liquefied by compression and cooling and returned to the propane work tank.

The bottoms from this secondary propane evaporator, P-2, are passed through the heating coil set in furnace H-1 where they are raised to 410 deg. F. and then by a combination, first an atmospheric P-3 and a vacuum P-4 distillation tower system, the Selecto and any propane not previously removed from the paraffinic fraction are separated. The latter fraction comprises the bottoms from the vacuum tower P-4 and possesses the following characteristics:

Characteristic of Bottoms from P-4

	Beaumont-Paulsboro
Gravity, A.P.I. degrees	29.6
Specific gravity, 60 F.	0.8783
Flash, deg. F.	460
Pour point, deg. F.	100
Viscosity, at 210 F.	71
V.G.C.	0.800
Color, N.P.A.	8
Percent acid	.08

The above oil requires dewaxing to bring it to specifications and is carried out by the Sharpless centrifuge dewaxing method.

Characteristics of Paraffinic Oil After Treatment

Gravity, A.P.I.	29.0
Specific gravity, 60 F.	0.8816
Flash, deg. F.	450
Fire, deg. F.	515
Viscosity at 100 F.	658
Viscosity at 210 F.	74
Viscosity Index	100
Color	Dark- 5
Pour, deg. F.	0- 20
V.G.C.	0.8035
Conrad carbon	0.20

At the Beaumont plant the above oil represents approximately 76 percent of the raw material while the tarry fraction is then 24 percent. The above oil is subjected to vacuum distillation whereby a full scale of refined lubricants of stable and quality characteristics is obtained.

The Selecto solution undergoes a similar process after the first of the initial depropanizing steps already alluded to. The bottoms from tower N-1 go directly to tower N-2, the secondary propane evaporator held at 45 lbs. pressure. The overhead product is cooled in a reflux condenser, from 335 to 110 deg. F. thereby returning the heavy constituents. The propane is then directed in a common line from tower P-2 to the previously mentioned compression plant for liquefaction and recovery.

From this secondary evaporator N-2 the Selecto bottoms go directly to the pipe heater H-2 originally mentioned. Three fractionating towers, the atmospheric N-3, the water-Selecto W-1, and the vacuum N-4, effect the oil and solvent separation. The atmospheric tower N-3 receives its charge from the heater H-2, at 550 degrees F. The reflux from this N-3 feeds N-4, the vacuum tower, while the overhead products from N-3 and P-3 feed the water-Selecto fractionating tower. H-1 furnace, as was mentioned, contains a coil which heats part of the reflux from N-4 to 600 deg. F. and returns it to the vacuum tower N-4. In view of the low distilling temperatures this latter operation is necessary to provide the additional heat of vaporization required in N-4. A pressure of 40 mm. is maintained in N-4 and superheated steam is utilized to reduce further the partial pressure.

The water tower W-1 operates at two pounds guage pressure. Its charge derived from the overhead products of N-3 and P-3 consists of propane, Selecto and stripping steam. Its name arises from the fact that water from the rundown tank is returned to the tower as reflux thereby removing overhead the propane and steam components. This effects a very complete solvent recovery. The bottoms from this tower consists of Selecto completely dehydrated, which is returned to the working tank. The propane removed overhead is separated in the rundown tank and then directed to the compression and liquefaction system.

The naphthenic oil, or tarry extract, is obtained from the bottom of the vacuum tower N-4 while the overhead product is returned to the atmospheric tower W-1 further processing. The naphthenic extract of the Beaumont plant has a 7.0 A.P.I. gravity or 1.022 specific gravity at 60 deg. F., Furol viscosity at 212 deg. F. of 133 seconds and about 0.03 percent acid content. The latter figure indicates a very efficient Selecto recovery.

As may be appreciated from the above description, the extraction part of the process is rather simple while the oil separation and solvent recovery is very intricate. In the latter connection it may be mentioned that the smooth running of the plants with the minimum amount of manual control is due to an unusually effective assortment of automatic regulators for pressure, temperature and flow. In addition to these, other interesting advancements are incorporated.

The smooth and very satisfactory function of these initial Duo-Sol commercial installations may be attributed not only to the theoretical and practical principles embodied in the design of the plants but also to the research, knowledge and experience of the organization that has undertaken its development and presentation to the petroleum refining industry.

(While these articles on the Duo-Sol installations are not complete—omitting descriptions of several plants now being erected and final treatment purifying decolorization of solvent treated raffinates—we hope to be able to publish further articles on this major refining development in early issues of WORLD PETROLEUM—EDITOR.)

Geology and Economic Significance of Central Michigan Fields

Fourth of a Series of Articles Dealing with Geology, Production, Reserves and Economy of the More Important Oil Fields in the United States.

By Basil B. Zavoico

THE TWO large Central Michigan oil fields, Greendale and Porter, are of great economic importance to the oil industry of the United States not only because of their own crude oil production and reserves, located in an area of very large motor fuel consumption, but also because these first two large fields of the central portion of Michigan basin, with an estimated ultimate recovery of about 53,000,000 bbl., may be considered to be typical of this new but little explored major oil producing area. Hence in the future development of Central Michigan the oil industry will draw heavily upon the actual experience gained in Greendale and Porter fields in facilitating the search for new fields and in adopting the most suitable and most economical development and production practices. This article accordingly deals with the subject not only in direct relationship to the Greendale and Porter fields, but also in a more general way so as to be helpful as a basis of economic studies for new discoveries in Michigan. Up to March 1, 1935, 681 producing oil wells were completed in Greendale and Porter-Yost fields, producing to that date 29,967,214 bbl.; while a recoverable reserve of about 23,182,786 bbl. is estimated to be still available. The development of Greendale field was completed by March of 1935, but the Porter-Yost area is still due for several semi-major extensions during the coming year, possibly bringing the total number of completed oil wells in both fields to 830.

The more outstanding features of Greendale and Porter oil fields are:

1. The location in an area of thick glacial drift of Pleistocene age, ranging from 250 to 300 ft., and obscuring all surface evidence of structural conditions, this being typical of the Lower Peninsula of Michigan, where locally glacial drift reaches a thickness of 1,000 ft. Greendale field was discovered on the strength of subsurface work done on shallow brine wells, while subsequent discoveries were made as new wildcat wells added to subsurface information.
2. The source of all production is the porous limestone of Devonian age, the Dundee, showing very sharp decline curves, with as much as 60 percent of ultimate production being recovered in the first year of active development.
3. The introduction and the development of practical acid treament in the Greendale field for the first time in the history of the oil industry, a revolutionary innovation which was rapidly adopted in hundreds of old and new oil fields throughout the country. Acid treatment added millions of barrels to the crude oil reserves of United States directly through increased recoveries and indirectly through accelerated rate of production of marginal wells.

Development

FIRST wells drilled in Central Michigan were completed by the Dow Chemical Company which otained heavily saturated brines for its chemical plant at Midland from the Marshall sand encountered at about 1,350 ft. These shallow salt water producing wells, some of which showed little gas and oil, drilled through the glacial drift and hence were invaluable for interpretation of the structural conditions of the area. Pure Oil Company secured the well records of the Dow Chemical Company, previously held confidential, and after their correlation and study it made, late in 1927, a location for its No. 1 L. Root in section 18, T. 14 N., R. 2 W., in Greendale township of Midland County. No. 1 L. Root was completed on February 8, 1928, in the Dundee limestone at 3,533 ft. for an initial production of 85 bbl. of 41.8 gravity crude oil per day, subsequently increasing to about 125 bbl. per day when deepened to 3,607 ft., plugged back to 3,598 ft. and shot. The discovery, called at first Mt. Pleasant field, resulted in drilling of some 175 oil wells by May of 1931 and a maximum monthly average daily production of 8,177 bbl. during February of 1930, under partial proration. To May 31, 1931, Mt. Pleasant field produced 4,606,254 bbl.

The Mt. Pleasant field was extended 1½ miles due east in May of 1931, the East Extension subsequently proving to be the most prolific portion of the Greendale field, as the Mt. Pleasant and East Extension sectors are now referred to. The East Extension was opened by the Kalamazoo Improvement Company's No. 1 G. Harnick in section 15, T. 14 N., R. 2 W., in Greendale township of Midland County, which produced 820 bbl. per day initially from Dundee limestone topped at 3,513 ft. and drilled to 3,548 ft. The discovery of the East Extension revived the Greendale field and its production increased to a daily peak of 21,639 bbl. during September of 1932, while the number of successful completions increased to 372 by March of 1935, of which, however, about 75 producers were abandoned in the interim period. The cumulative recovery from Greendale field reached 17,277,207 bbl. by March 1, 1935.

The Porter field was discovered in November of 1931 by the Michigan Pacific Oil and Gas Company's No. 1 J. Otway in section 26, T. 13 N., R. 1 W. in Porter township of Midland County, which produced 118 bbl. initially from the Dundee limestone topped at 3,382 ft. and drilled to 3,431 ft. This discovery well proved to be an edge well and all its offsets were completed as failures, thus delaying the development of the field, and it was not until February of 1933 that the same company's No. 2 J. Otway in section 22 and half a mile due northwest from the discovery was brought in flowing initially 3,200 bbl. per day from the Dundee topped at 3,370 ft., and drilled to 3,445 ft., thus proving the Porter field for prolific production. The subsequent development campaign was very rapid and by March 1, 1935, the Porter field had 295 producing oil wells; it produced 12,077,161 bbl. to that date, while the average daily rate of production under proration reached its peak of 27,000 bbl. per day during February of 1935. Though the Porter field was actually discovered by the Michigan Pacific Oil and Gas Company the area was always considered semi-proven by the Pure Oil Company which controlled at the time of discovery about 43 percent of currently productive acreage in the pool. The standard Mid-Continent well spacing

practice of 10 acres per well has been adopted in Greendale and Porter fields, excepting certain limited areas where tight Dundee limestone made such close drilling uneconomical.

The Yost field, which may be considered as the northwest extension of Porter field, was discovered in December of 1932 by the Pure Oil Company's No. 1 Yost in section 34, T. 14 N., R. 2 W., in Greendale township, which produced initially 1,127 bbl. from 3,457 ft. in the Dundee limestone topped at 3,421 ft. Pure Oil Company controls all the acreage in the Yost pool, and that factor together with very thin pay section in the Dundee resulted in conservative development of the field with well spacing of 20 acres per well. To March 1, 1935, the 16 completions have recovered 612,846 bbl. of crude oil.

The statistical data, presented in Table 1, shows production, development, recoveries and estimated reserves of Greendale and Porter-Yost fields. While the indicated reserves may be considered somewhat high in the case of the Porter field it is thought that the water drive, which is non-existent in the Greendale, will prove to be the major favorable influence.

Proration History

PRORATION was first applied to Central Michigan oil fields in 1930 when the actual production from the Greendale field was limited to 60 percent of its potential, necessitated in part by limited market and transportation facilities. Proration machinery in 1930 was handled by the Pure Oil Company, the major purchaser of crude oil in Michigan at that time, in cooperation with other producers in the field. With the decline of production the Greendale field was allowed to produce wide open and the subsequent discovery in 1931 of the East Extension came at a time when the increased production found markets available.

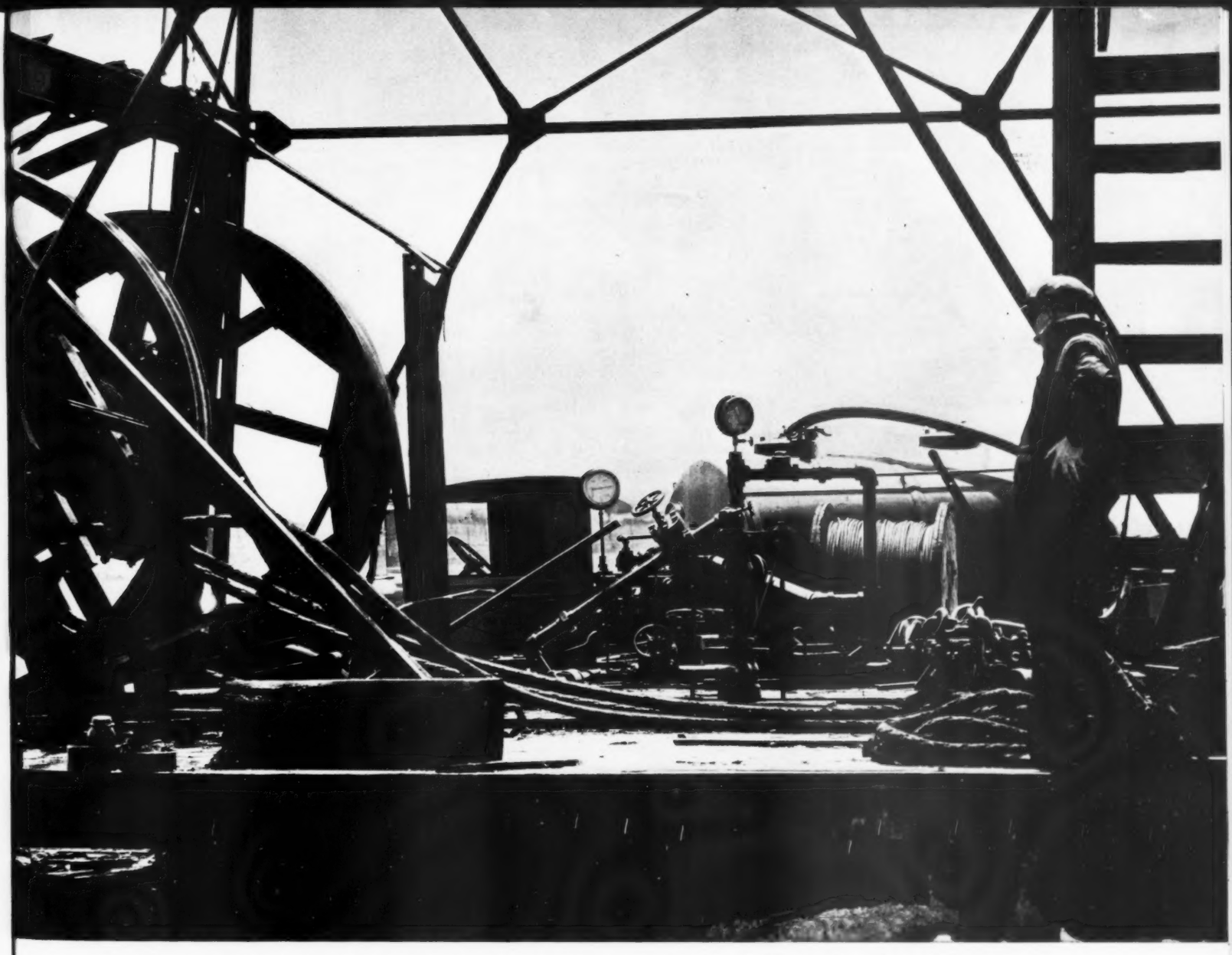
Only in the late Summer of 1933, with the discovery of large flush production in the Porter field, production in Michigan began to exceed greatly the market demand, while many operating companies and individuals made proration regulations advisable. The State of Michigan, however, had no machinery or available personnel for handling proration. Accordingly in September of 1933 the producers of the state, acting under section 5 of Article III of the Code of Fair Competition for the Petroleum Industry, petitioned the Petroleum Administrator for a Supplemental Code for Michigan, which was approved by the Administrator on September 22, 1933. The Supplemental Code provides for a Committee of 7 members, the "Michigan Producers Proration Committee", to be selected by the producers of the state and approved by the President. The duties of the Committee include the determination of the reasonable market demand for Michigan crude oil based on bona fide nominations of purchasers; the determination of the potential production of the state; and the allocation of the state's federal allowable among the various pools, leases and wells. The Committee employs umpires and a clerical force to carry out its proration orders as approved by the Petroleum Administrator. The expense of the administration of proration is borne by all operators who contribute at this time one eighth of a cent per barrel to the proration fund. Proration in Michigan has been, in fact, a voluntary and cooperative undertaking, and with the exception of one producer has been strictly adhered to.

From September, 1933, to January, 1934, the potential production was determined on the basis of 6-hour open flow tests on all wells, with the last 2-hour production being multiplied by 12 for determination of 24-hour potential. Under this method the daily potential of Porter-Yost increased to 93,230 bbl. in January, 1934, in which month the daily production averaged 16,174 bbl. In the following 3 months, February, March and April, 1934, the potentials were based on one hour flow tests with the potential of new wells being calculated at 70 percent of one hour flow multiplied by 24, and the potential of old wells was determined at 78 percent of one hour flow tests multiplied by 24; in this period of time the daily potential of Porter-Yost increased to 115,369 bbl. in April, in which month the daily production of these two fields averaged 19,967 bbl. From May to November of 1934 potentials were determined by 3-hour tests of wells producing in excess of 500 bbl. per day, the last hour's production being multiplied by 24, while wells under 500 bbl. per day were tested for 24 hours for their rating, the tests in that period were made bi-monthly with monthly interim declines fixed at 7 percent for wells over 500 bbl. and at 3 percent for wells under 500 bbl.; under this method of testing wells the potential production of Porter-Yost reached its maximum of 171,052 bbl. per day in July, 1934, in which month the actual production averaged 21,763 bbl. In November of 1934 the potential was determined by a 10 percent flat decline from the preceding month on all wells, while in December, 1934, and January, 1935, the decline curve method on all wells individually was attempted. Beginning with February of 1935 the so-

TABLE 1

Production, Development, Recoveries and Estimated Reserves of Central Michigan, to March 1, 1935

	Total	Porter	Greendale	Yost
Actual Producing Area, acres	9,710	3,330	5,850	530
Probable Extensions, acres	1,440	700	———	740
Estimated Total Productive Area, acres	11,150	4,030	5,850	1,270
Number of Completed Oil Wells	681	293	372	16
Average Well Spacing in Producing Area, acres per well	14.26	11.38	15.72	33.10
Number of Abandoned Oil Wells	91	12	78	1
Estimated Ultimate Number of Oil Wells	830	370	400	50
Current 24-hour Potential Production, bbl.	45,467	38,809	3,840	2,818
Average Daily Production during February 1935, bbl.	33,040	27,230	3,840	1,970
Total Recovery to March 1, 1935, bbl.	29,967,214	12,077,161	17,277,207	612,846
Recovery per Well to March 1, 1935, bbl.	43,900	41,200	46,300	38,300
Recovery per Producing Acre to March 1, 1935, bbl.	3,080	3,620	2,950	1,160
Estimate of Reserves				
Estimated Ultimate Average Recovery per Acre, bbl.	4,760	7,000	3,500	3,500
Estimated Total Ultimate Recovery, bbl.	53,150,000	28,200,000	20,500,000	4,450,000
Estimated Ultimate Recovery per Well, bbl.	61,500	70,800	51,200	88,900
Remaining Recoverable Reserves, bbl.	23,182,786	16,122,839	3,222,793	3,837,154



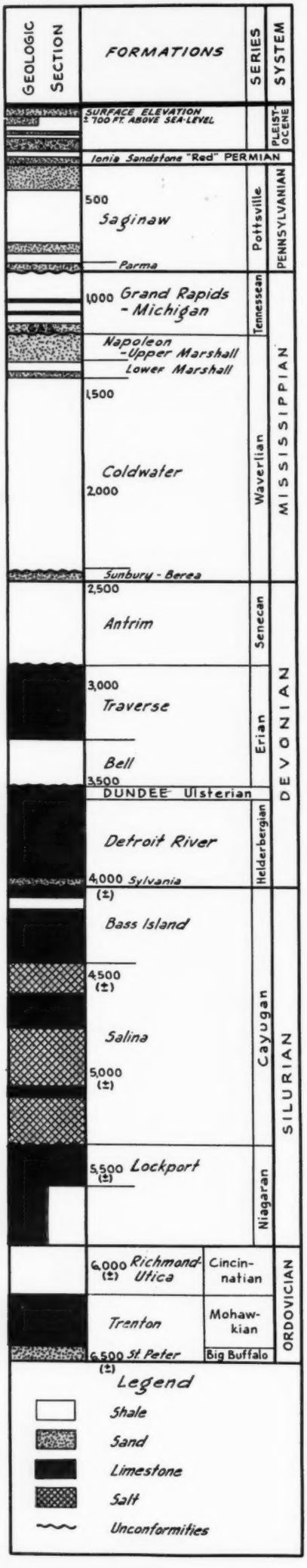
Dowell Acid treatment actually being administered to a Central Michigan well.

called "pressure potential" method of determining potentials was introduced, under which all operators were given considerable freedom in fixing the actually feasible production from their wells in consideration of maximum flow, water encroachment and gas pressure. The change in the method of determining potentials reduced the potential production of Porter-Yost from 130,139 bbl. in January of 1935 to 38,517 bbl. daily in February of 1935, thus showing remarkable cooperation of all producers. During the whole proration of the Porter-Yost field the allowable was based on a minimum exemption, which varied between 50 and 100 bbl. per day, and a percentage allowable above the exempted minimum depending upon the current potentials and the market demand.

Drilling Practice and Costs

ALL DRILLING in Greendale and Porter fields is done with standard cable tool rigs. Contractors drilled most of the wells, though a few of the larger producers operated their own rigs. The drilling in Central Michigan is through formations that do not cave badly and but few difficulties were encountered in the development. The glacial drift composed of sand, gravel, clay and boulders, from surface to about 300 ft., contributed one of the difficulties in Central Michigan; 10-inch drive pipe string with a drive shoe is now used in drilling through the drift, setting it at about 325 ft., but the process is still very slow requiring as many as 5 days, while in areas where the drift is 500 to 600 ft. as many as 20 days are required for drilling through it. With wildcatting in Central Michigan gradually advancing into the area where glacial drift exceeds 500 ft. and reaches 1,000 ft. it was economically imperative to reduce time and expenses for drilling through it and a combination light rotary and standard cable drilling rig has been developed which drills through the drift with rotary tools in 3–4 days instead of as many as 3 weeks, while cable tools make the balance of the hole.

The equipment used in drilling includes standard steel derricks of Ideco and Moore types 84 ft. high and measuring 20 x 20 ft. at base, though many of the smaller operators used wood derricks. All power for drilling was furnished by gas engines, including Clark type M-2, 4-cylinder vertical, 4-cycle, 120 H.P. units; Bessemer 1-cylinder 12½ x 16; Hercules 90 H.P. units and others. All derrick equipment, steel bull wheels, sand reels, rig fronts, etc. as used in Michigan are of standard type. Drilling lines used are ⅞-inch in diameter 6 x 7, and the sand



Geologic section of Greendale and Porter-Yost fields in Central Michigan.

lines are ½-inch 6 x 7. Around 300 ft. of 2¼-inch manila rope is generally used at the bottom of the drilling line, called "cracker," thus giving for a brief period at the beginning of motion a longer stroke to the bit than is possible with steel cable, though this practice is not necessary, being rather a local custom. The average time of drilling in and completing a producing well in Central Michigan is around 38 to 40 days at this time, though earlier wells required as much as 55 days for completion. The standard casing program includes about 325 ft. of 10-inch, 41.85-lbs., casing with a drive shoe; about 900 ft. of 8¼-inch, 28-lbs., of "cave string" set through a badly caving formation in Parma section and pulled out of the hole after landing the 6⅝-inch string; about 1,375 ft. of 6⅝-inch, 20-lbs., casing and around 3,450 ft. of 5 3/16-inch, 17-lbs., casing with a casing shoe. As a general practice none of the casing strings are cemented, though the 6⅝-inch string is mudded off with fine fire clay through the Marshall sand to save the valuable brines of that formation from pollution.

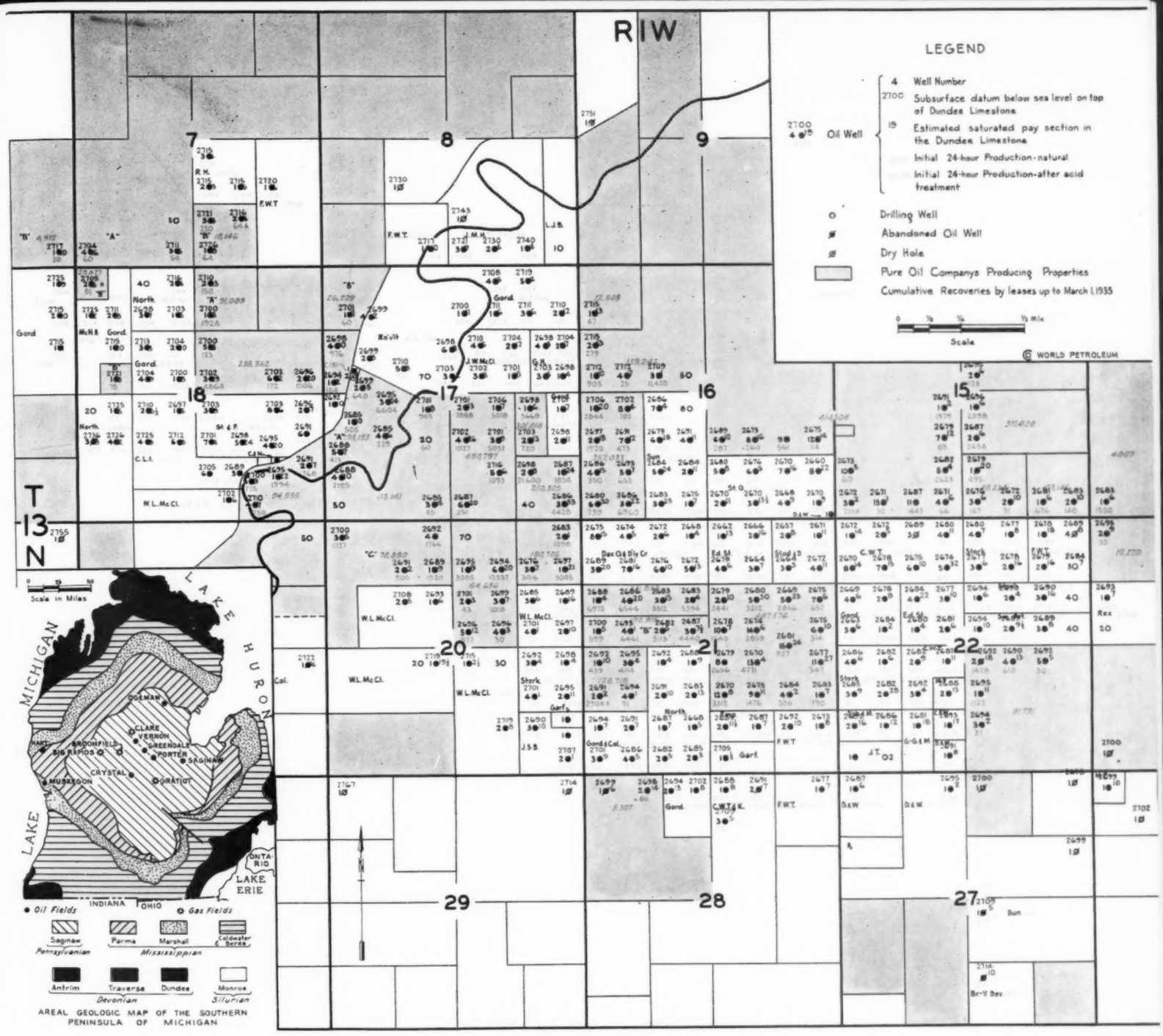
The wells in Central Michigan are brought into production by drilling into the Dundee limestone very slowly, a few feet each day, in order to determine the exact depths of porous zones. Inasmuch as the bottom-hole pressures are relatively small, around 1,400 lbs. and the well head pressures do not exceed 500 to 600 lbs., while the gas volumes are low, only very light control heads and flow lines are used, the gas oil separators are 3 x 10 ft. Flowing wells are usually produced through 2-inch E.U., 4.7-lbs., tubing.

The current cost of a completed and fully equipped flowing well in Greendale and Porter fields is around $14,000. Prior to 1932 drilling costs averaged around $26,000 per well, dropping to $19,000 in 1932, and to $16,000 in 1933. "Contract" drilling prices starting at $3.00 per foot in 1930, dropped to $1.75 per foot in 1933, and to $1.55 per foot in 1934. The total drilling development expense for 681 wells completed in Greendale and Porter-Yost fields up to March 1, 1935, was therefore around $12,660,000 divided as follows: $5,000,000 for 200 early wells in Greendale-Mt. Pleasant; $3,320,000 for 175 wells in Greendale-East Extension; and $4,340,000 for 310 wells in Porter-Yost. The interest charges on development costs in Greendale field have not been excessive, the field having paid for its drilling within few months of active development; while in Porter field with less costly drilling and large flush production they have been negligible. The anticipated additional 150 wells in Porter-Yost area, with few more in Greendale, will involve an outlay of $2,100,000, or a grand total development expense for both fields of $14,760,000.

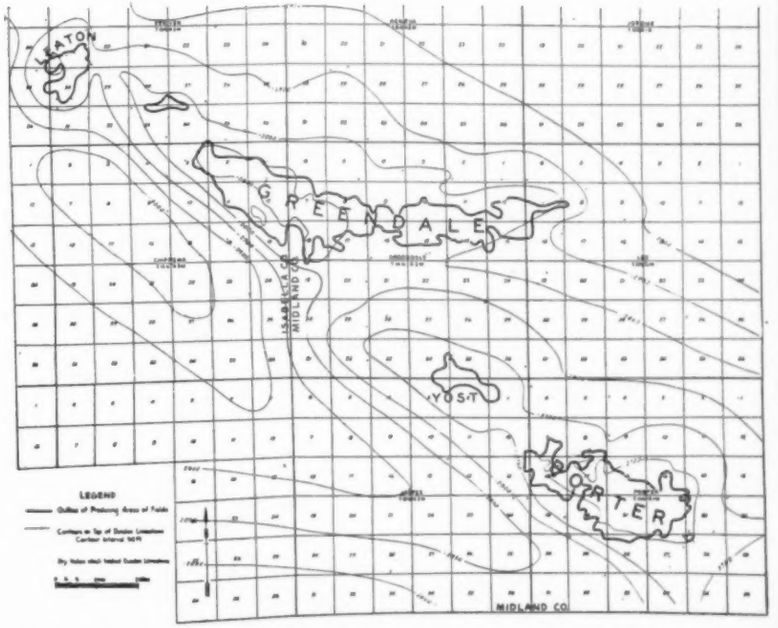
Production Practices and Costs

IN MARCH 1935 of the 293 completed oil wells in the Porter field only about 14 percent, or about 40, were flowing naturally, while the remaining 253 were using various types of pumping equipment. In the older Greendale field all wells were on the pump. The flowing wells in Porter field, ranging up to 20,000 bbl. per day initially, are allowed to produce through standard valves adjusted to the desired opening, only about a dozen of Schaffer special chokes having been installed by the Pure Oil Company. Under proration and in order to delay salt water encroachment large flowing wells are produced under back pressures ranging up to 400 lbs. As will be indicated subsequently in this article most of the larger flowing wells in the Porter field show rapid salt water coning and encroachment necessitating various forms of oil treatments. The gas oil ratio in the Greendale and Porter fields varies from 750 to 1,000 cu. ft. per barrel of oil lifted, all of the gas being originally in solution. The natural gas contains about 0.75 gallons of recoverable natural gasoline per 1,000 cu. ft. at a gathering line pressure of around 40 lbs.; and about 1.5 gallons per 1,000 cu. ft. at a gathering line pressure of 3 to 5 lbs. There is no excessive gas wastage in Greendale and Porter fields, though lack of sufficiently large natural gas outlets, which are not economically justified, necessitates blowing into the air of considerable volume in the periods of flush production. Artificial lifting methods in Michigan include various forms of pumping, gas lift not being used. The different pumping methods include: (1) single beam installations using sucker rods or, to a smaller extent, steel cable; (2) multiple beam and jack installations with two to three wells being pumped with one engine, a method called "back-cranking"; (3) jack pumping from central powers; and (4) pneumatic pumping cylinders.

The single beam installations are in general use in Greendale and Porter fields because they are best adapted to operators with a limited number of wells and without mobile pulling equipment, only larger operators using the remaining three pumping methods. The approximate cost of a single beam installation is around $5,365, as is shown in detail in Table 2.



Map of Porter Field showing acreage distribution, development, Dundee limestone subsurface elevations, estimated thickness of pay zones in Dundee, initial production and cumulative recovery by leases to March 1, 1935. Legend of Abbreviations in Table 4, Page 321. In insert—areal geologic map of the Southern Peninsula of Michigan.—Note location of new discovery at Crystal.



Subsurface structure on Dundee limestone and field development map of Central Michigan.

TABLE 2

Analysis of Drilling and Standard Beam Pumping Equipment Costs in Central Michigan in 1934 and 1935

Total footage drilled to March 1, 1935—2,400,000 ft.

To Lease Investment		$ 8,912
Including: Clearing location and road building	$ 175	
Derrick and crown block	650	
Well head connections	250	
325 ft. of 10-inch 41.85 lbs. casing and drive shoe	600	
900 ft. of 8¼-inch 28 lbs. casing (pulled out)	—	
1,375 ft. of 6⅝-inch 20 lbs. casing	1,170	
3,450 ft. of 5³⁄₁₀-inch 17 lbs. casing and shoe	2,490	
3,500 ft. of 2-inch E.U. 4.7 lbs. tubing	910	
Separator 3 x 10 ft.	300	
Flow lines	300	
2-500-bbl. steel tanks	792	
Lumber, concrete and miscellaneous materials	375	
Labor, hauling and freight	900	
To Drilling		$ 3,400
Including: Labor	$1,665	
Compensation insurance	110	
Hauling	175	
Supplies	600	
Repairs	400	
Depreciation of drilling equipment	450	
Gas fuel for gas drilling engine (no charge)		
Note: Drilling on contract at $1.55 per foot amounts to $5,275		
To Standard Beam Pumping Equipment		$ 5,365
Including: 40 H.P. gas engine complete with clutch, etc.	$1,660	
Steel front (6-inch irons) with walking beam, etc.	1,375	
Concrete foundations	500	
Engine house and belt house	350	
Miscellaneous fittings and connections	75	
Belt	180	
Circulating water tank	200	
3,500 ft. of ¾-inch sucker rods	465	
2-inch by 10 feet Insert type working barrel	35	
Labor, hauling and freight	525	
Grand Total for Completed and Equipped Well: with company's tools		$17,677
on contract drilling		$19,552

If economy is the principal object less satisfactory single beam installations can be put up for around $4,000, made out of used equipment and using wood fronts. Tubing in general use is 2-inch and 2½-inch E.U. 4.7 lbs. and 6.5 lbs. respectively, with a 2-inch by 10-foot insert type barrel at the bottom of the well, which allows the barrel to be pulled out without tubing, however, a large number of standard barrels of old type are still in use. The power is usually supplied by a 40 H.P. gas engine. Sucker rods used in Central Michigan are ¾-inch 1.67 lbs. in 2-inch tubing; and are of tapered type in 2½-inch tubing, 1,175 ft. being ⅞-inch 2.24 lbs. rods and 2,225 ft. being ¾-inch 1.67 lbs. rods. Wire line pumping is still being used on some 75 wells of smaller operators, but it is being discarded and replaced by sucker rods. Wire line pumping is definitely unsuitable for 3,500-foot oil wells because the cable of that length stretches two to three times as much as the sucker rods, which in view of the average 48-inch stroke renders wire line pumping wholly ineffective at times. The pump stroke of wells on beam is usually 48 inches, though a maximum of 72 inches may be used. Maximum fluid production from wells on beam is around 500 bbl. per day.

Multiple beam and jack installations of "back-cranking" type are similar to beam type described above, the key well with engine and beam being connected by rod lines to one or to two nearby producers on which standard pumping jacks are used. This type of pumping equipment costs $5,365 for the key well and but $850 additional for each of the two connected wells, or a per well average of $2,355 for a 3-well installation. Standard pumping jacks in use in Michigan are made by the National Supply Company, types C-100 and D-100; by Oil Well Supply Company; by Jenson, type 6, and by other manufacturers. The pump stroke of wells on pumping jacks is 38 inches, and on "back-crank" installations the maximum fluid capacity of wells is around 100 bbl. per day each.

Where many wells can be handled from a central station, pumping powers are built, as Pure Oil Company did in the Greendale field. The four powers in operation in that field are equipped with 60 or 80 H.P. single cylinder 2-cycle Cooper-Bessemer gas engines and National type 12-C band wheel powers. The four powers in the Greendale field are connected respectively to 14, 14, 15 and 21 wells producing on standard pumping jacks, as described above, all four installations, 64 wells, currently producing 630 bbl. per day. Rod lines are ⅞-inch in

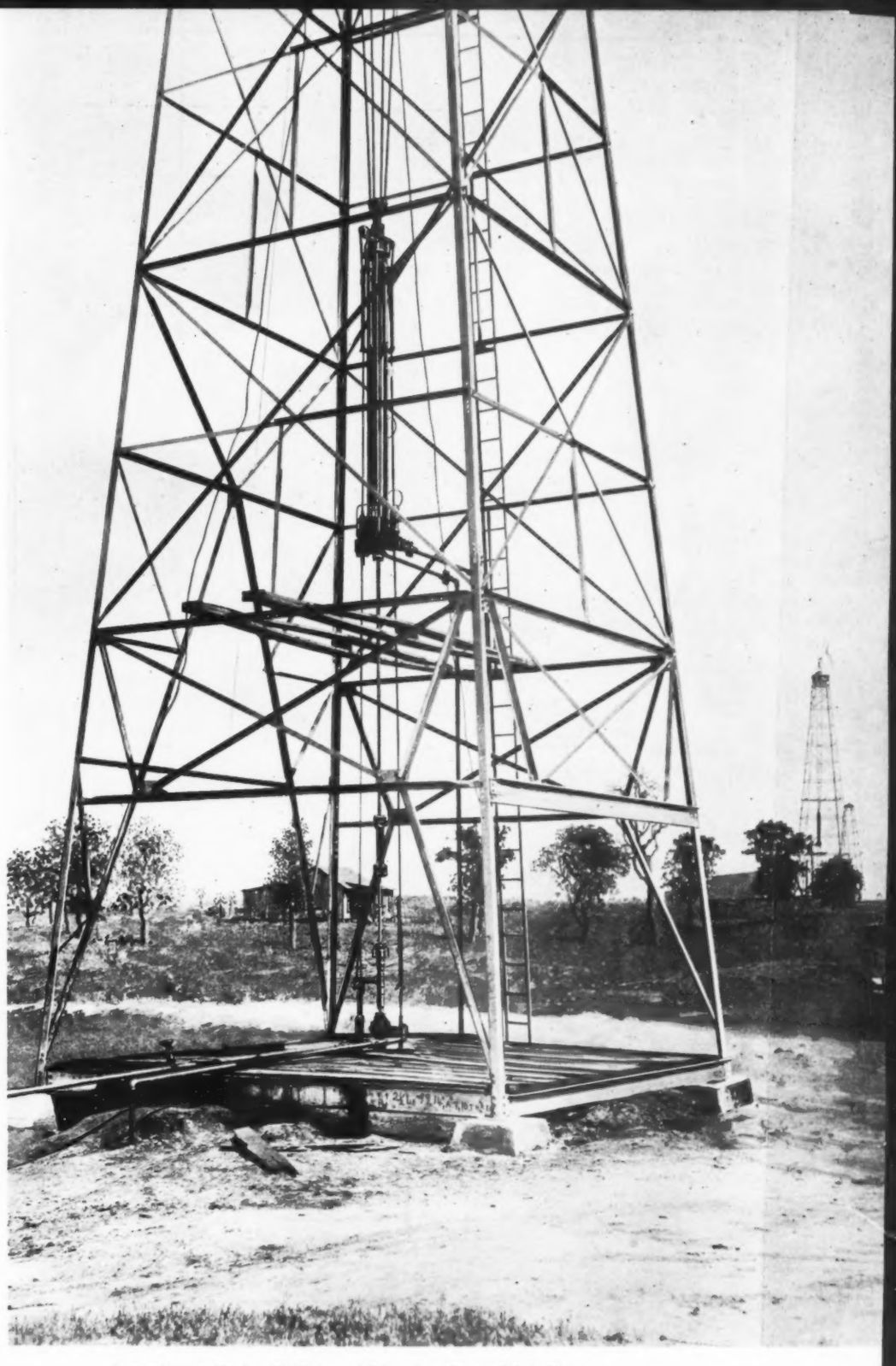
TABLE 3

Analysis of Typical Crude Oil from the Greendale and Porter Fields, Michigan

A.P.I. gravity	42.0		
Sulphur content, percent	0.18		
Viscosity	S.U. 39 at 70° F		
Color	dark green		
Base	paraffin		
Gasoline and Naphtha content:			
Gasoline:	E.P. 325° F	E.P. 400° F	E.P. 400° F reformed
Percent	23	36	72 of E.P. 400
Gravity A.P.I.	68	62.5	62
Octane No.	36	22	61
Sulphur content, percent	0.030	0.035	0.040
Naphtha, 325° to 400° F			or 25.8 percent net;
Percent	10		also 685 cu. ft. of gas
Gravity A.P.I.	53		per bbl. of charge.
Sulphur content, percent	0.048		
Kerosene distillate:		Fuel Oil:	
Percent	27	Percent	33
Gravity A.P.I.	43	Gravity A.P.I.	12.3
Sulphur content, percent	0.092	Viscosity at 122° F	25
		Flash, P.M.	165
Gas Oil:			
Percent	12.5		
Lubricating Stock:			
Percent	10.0		
Residuum and Loss:			
Percent	17.5	17.5	
From topped Crude Oil, 55 to 60 percent of original crude:			
Gasoline by cracking:			
Percent	60	(or 36.0 percent of crude oil; also 500 cu. ft. of gas per bbl. of charge)	
Gravity A.P.I.	61		
Octane No.	65		
Sulphur content, percent	0.060		

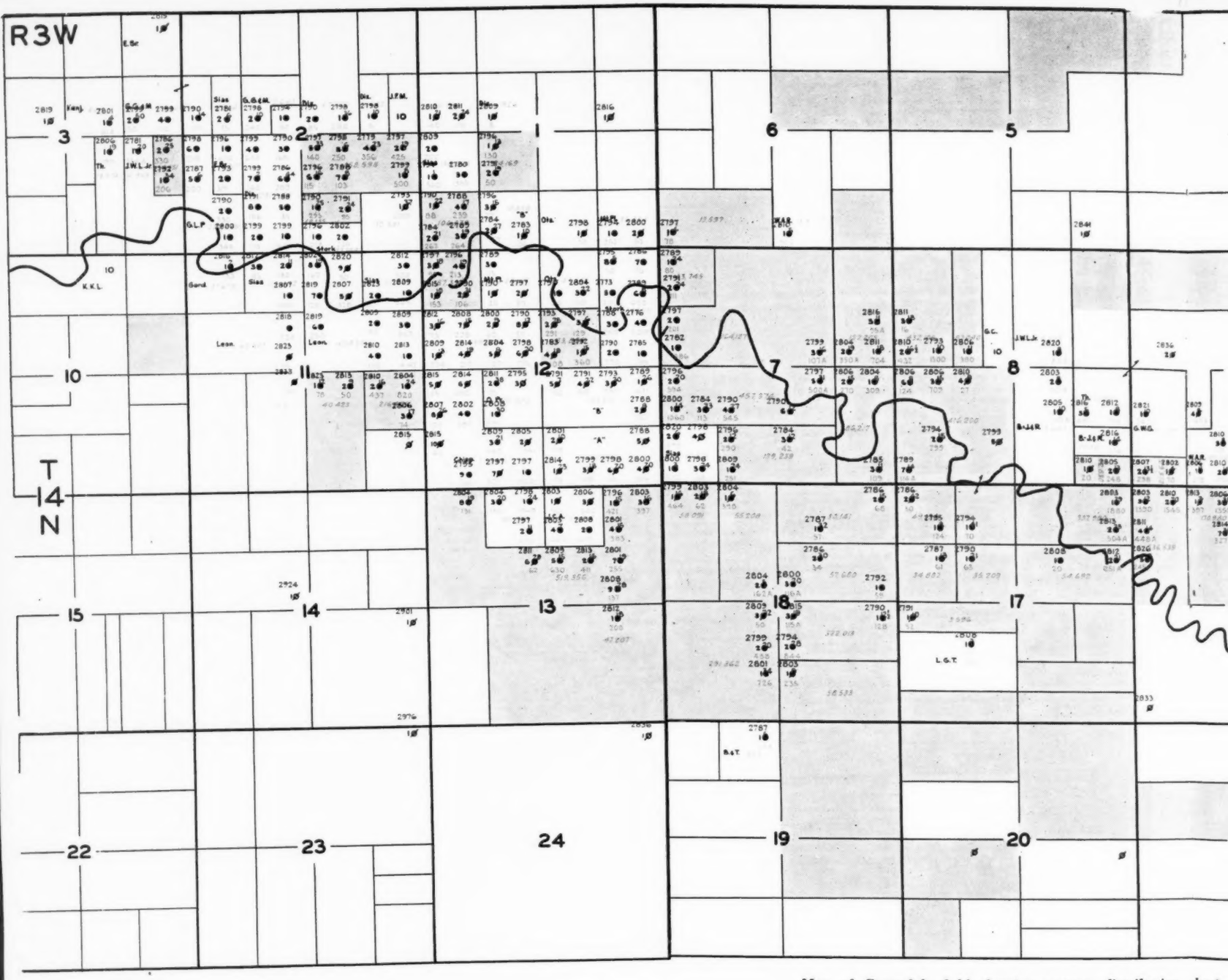
diameter for distances under 1,500 ft. and 1 inch in diameter for distances above 1,500 ft., with the longest rod line being 3,700 ft. Maximum fluid capacities of individual wells are 100 bbl. per day, though the power as a whole has a maximum capacity of not over 300 bbl. per day. The per well cost of installation of central powers is around $1,500, $1,000 being pro-rata share for engine, band wheel, belt and housing, and $500 being for equipment and connections of individual wells.

The latest and most modern pumping installations in Michigan fields are of pneumatic cylinder type developed by the engineering department of the Pure Oil Company and now manufactured under license by the Sullivan Machinery Company. This equipment consists of Cooper-Bessemer type GMO combination gas engine (12½-inch by 16-inch, rated at 70 B.H.P.) and two-stage one-clyinder compressor (7½-inch by 16-inch). The low pressure, make-up end of the compressor cylinder takes the air from the atmosphere and delivers it to the high pressure, circulating end of the compressor cylinder at 75 lbs., which in turn puts it into 3-inch lines to wells at 250 lbs. The air is heated in special heaters on the way to the pneumatic cylinders to increase its volume, thus reducing the necessary compressor horse power, and after it is used in the cylinder it is returned to the circulating end of the compressor cylinder through 4-inch lines. The pneumatic cylinder itself is of single-acting type and is equipped with automatic air-actuated poppet valves; it is installed vertically in the derrick, as is shown in the accompanying photograph, and is connected to sucker rods. This equipment has been developed to permit operation of wells commensurate with their potential output, to provide a pumping unit that reduces stress on sucker rods, to have a standard installation of great flexibility in producing capacities and in power requirements of individual wells, and to provide equipment with a high salvage value. The reduction of stress on sucker rods is achieved by reduction of early high impact loading common to beam pump wells, which is due to variable acceleration of bean motion as compared with uniform acceleration of pneumatic pumps; and because of the cushioning effect of air in the air cylinder, as compared with rigid motion of beam or jack. The standard stroke of pneumatic cylinders is 72 inches; the speed can be varied between 3 and 35 strokes per minute, with the average operating range around 18 to 20 strokes; while the fluid production of pneumatic cylinder equipped wells ranges up to 500 bbl. per day with 2-inch insert barrels and up to 1,000 bbl. per day with 2½-inch insert barrels. One power installation of indicated type operates three wells and the cost of equipment is $3,750 per well, all inclusive.



Pumping wells in Michigan field using Pure Oil-Sullivan pneumatic cylinder pump.

The direct lifting costs in Greendale and Porter fields naturally vary greatly with the size of the wells, type of pumping equipment and amount of salt water production, but may be considered to average between 15 and 25 cents per barrel, this figure not including development, depreciation and overhead charges.

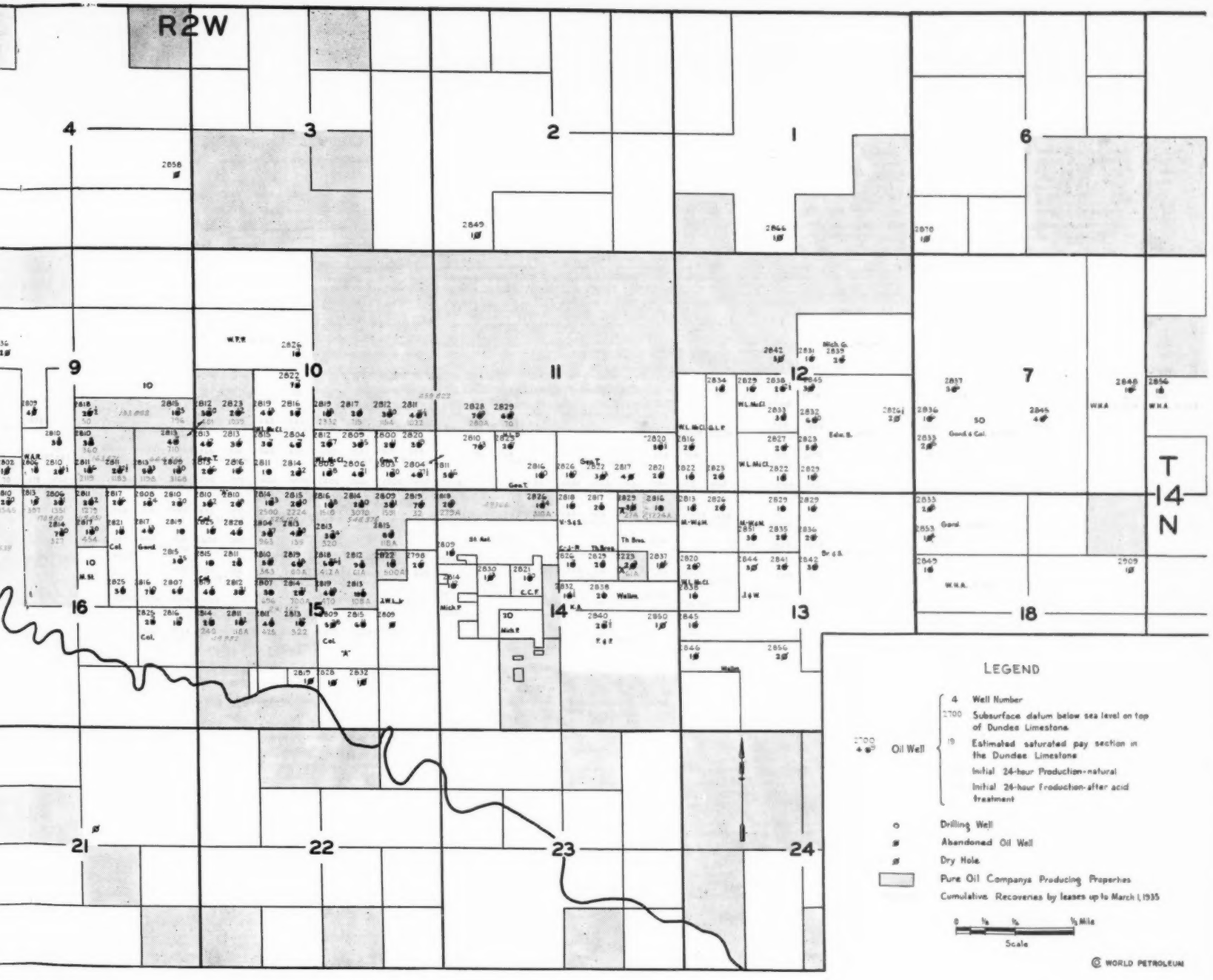


Map of Greendale field showing acreage distribution, develop Dundee limestone subsurface elevations, estimated thickness zones in the Dundee, initial production and cumulative reco leases to March 1, 1935. Legend for Abbreviations on Table 321. Sections 10 and 15, principal area affected by salt wa croachment has shown greatest oil recovery.

In Greendale and Porter fields because of the considerable paraffin content of crude oils paraffin wax deposits accumulate on tubing and on rods, principally in the upper 1,000 to 1,500 ft., thus decreasing the effective pumping aperture and reducing production. The deposition of paraffin wax is caused by liberation of gas from solution and by cooling effect as the oil approaches the surface, the reservoir temperature being around 105 deg. F in Greendale and Porter. The Dow Chemical Company developed through its subsidiary, the Dowell Incorporated, a very effective paraffin disintegrating medium called Dowell Paraffin Solvent, which, if properly applied, completely removes and puts in suspension all solidified paraffin wax which is then pumped out of the well by usual methods. The Dowell Solvent comes in a concentrated form and is blended with naphthas to secure proper specific gravity desired in treatments. This treatment of paraffin wax congested wells eliminates pulling sucker rods and tubing, as was the usual practice before. Another source of well clogging in the Mt. Pleasant sector of the Greendale field is the salt deposition in tubing derived either from salt crystals in the Dundee limestone or from supersaturated brines in the producing formation; this accumulation is cleaned out by simple fresh water circulation, about 35 wells being treated in this manner at regular intervals.

Acid Treatment

TREATING oil wells with acids as a method of increasing production, which was proposed nearly forty years ago by Frach, remained a dormant idea until recently improved by the cooperative efforts of The Pure Oil Company and The Dow Chemical Company. The Pure Oil

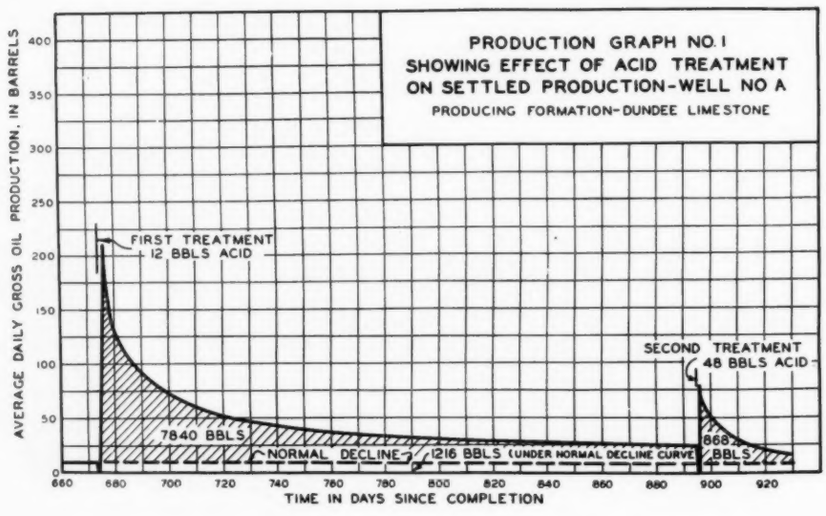


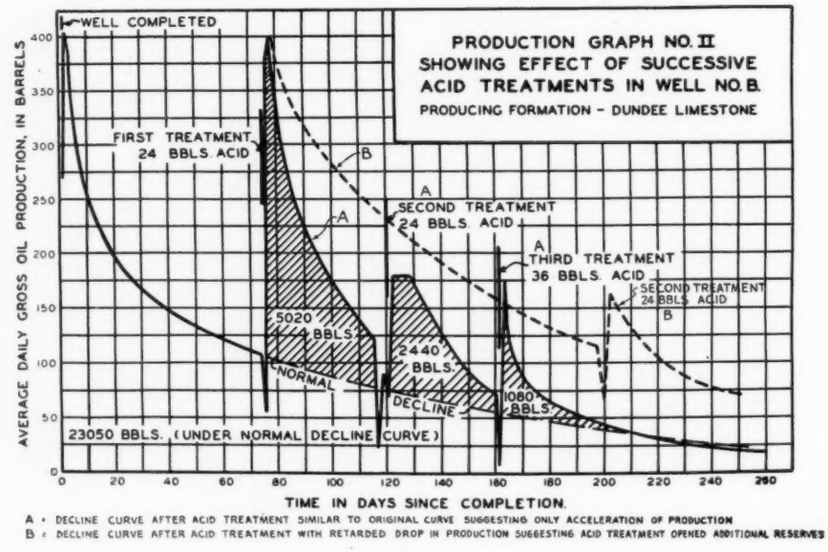
...ion, development, ... thickness of pay ...lative recovery by ... on Table 4, Page ...by salt water en... ...very.

Company's well, Fox No. 6, in the Greendale pool (Michigan) was the first well treated with improved acid composition by The Dow Chemical Company. The present day method of introducing acid through the well tubing under pressure, was developed by The Pure Oil Company. These improved methods revived and greatly stimulated the use of acid to increase production of oil and gas wells.

At this writing, the use of properly blended and inhibited acids to stimulate and increase oil production has long since passed the experimental stage. In fact, acid treatment is one of the scheduled ... in the completion of the smaller producing wells in central Michigan fields.

Acid treatment is ideally suited to limestone fields, such as Greendale and Porter, though in many cases sands cemented with calcareous matrix have also responded remarkably well. In Greendale and Porter fields the producing formation, the Dundee, ranges from fairly pure limestone in Greendale and in the eastern portion of Porter, to dolomitic limestone in the western part of Porter. The hydrochloric acid (HCl), inhibited against corrosion of casing and tubing, is introduced into the well through the tubing and is allowed to stand in the well until the reaction is completed, after which the well is allowed to pump off the resulting fluid. The acid, as used in the oil wells, averages 15 percent in strength for pure limestones, in which case the reaction is completed in six hours; and up to 20 percent in strength for dolomitic limestones, in which case the reaction takes as much as 72 hours, Dowell Incorporated having developed for dolomitic limestones a more effective acid solvent than the hydrochloric acid (HCl). Similarly special acid mixtures have been developed for low rock pressure formations which result in solutions of very low surface tension, and permit the spent solutions to be far more easily pumped from the well.




PRODUCTION GRAPH NO. II
SHOWING EFFECT OF SUCCESSIVE
ACID TREATMENTS IN WELL NO. B.
PRODUCING FORMATION - DUNDEE LIMESTONE
AVERAGE DAILY GROSS OIL PRODUCTION, IN BARRELS
WELL COMPLETED
FIRST TREATMENT
24 BBLS. ACID
SECOND TREATMENT
24 BBLS. ACID
THIRD TREATMENT
36 BBLS. ACID
SECOND TREATMENT
24 BBLS. ACID
5020 BBLS.
NORMAL DECLINE
2440 BBLS.
1080 BBLS.
23050 BBLS. (UNDER NORMAL DECLINE CURVE)
TIME IN DAYS SINCE COMPLETION.
A = DECLINE CURVE AFTER ACID TREATMENT SIMILAR TO ORIGINAL CURVE SUGGESTING ONLY ACCELERATION OF PRODUCTION
B = DECLINE CURVE AFTER ACID TREATMENT WITH RETARDED DROP IN PRODUCTION SUGGESTING ACID TREATMENT OPENED ADDITIONAL RESERVES

Generalized decline curves of acid treated wells in Greendale field.

To date, more than 1,000 acid treatments have been administered to oil wells in the state of Michigan.

In the Ogemaw field the wells producing from the Dundee limestone only show small initial production, very seldom exceeding 25 bbl., but these wells, after being given one or more acid treatments, increase their production up to 200 bbl. per day. The use of acid in Ogemaw constitutes the difference between producers and dry holes. One or two other small fields, in Michigan, such as Oceana and Hart and the Edmore, have likewise been made profitable by acidization.

Very briefly the technique of to-day's acid treatment is as follows. With tubing in the well the annular space between casing and tubing is filled with oil and in case salt water is present in the bottom of the hole from three to eight gallons of "Brine Seal" or some fine fire clay is introduced through tubing, which, however, is not too effective a medium in preventing acid from working downward around the seal. Inasmuch as presence of water in the well will dilute the acid and hence slow up the reaction, if at all possible, the water is forced out of the well through tubing by applying pressure on the column of oil in the annular space. The acid is then introduced through tubing, followed by oil, and as soon as reaction takes place usually a vacuum is created in the annular space, but if reaction is delayed pumps force the acid into the formation at an added pressure of 600 to 700 lbs., the original hydrostatic head of oil in tubing being equal to about 1,250 lbs. Twelve to 48 barrels of acid are currently used in acid treatments. One thousand gallons, about 12 bbl., of 15 percent acid solution will dissolve about 10 cu. ft. of pure limestone.

The economic effect of acid treatment is twofold: (1) it accelerates the recovery of given volume of oil, and (2) it adds to the reserves of crude oil by reaching portions of formation otherwise sealed and not likely ever to be drained. The acceleration of recovery benefits the producer by cheaper producing costs and by permitting many wells to produce when without acid treatment they would have been abandoned as non-commercial, thus indirectly also adding to the recoverable reserves of the fields. Usually the well decline curves indicate clearly the subsurface effect of acid treatments; if the increased production after acid application declines at the same rate as the well declined after its completion then it is presumed that merely the rate of recovery has been accelerated, if, however, the decline curve flattens out as compared with the original decline curve then it is deduced an additional source of oil has been reached, as is illustrated on the accompanying charts. Successive acid treatments have been found very satisfactory, and many wells in Greendale and Porter fields have been treated two and three times. Each successive treatment, however, usually obtains smaller and smaller increases in production, until further treatments become ineffective. The time of first application of acid and of succeeding treatments is an important factor in securing best recoveries and is given detailed study by field engineers. Observations of acid treatments reveal that it is not a good policy to treat the wells immediately upon their completion but rather the wells should be produced for a period of time sufficient to establish the movement of the fluid into the well. In wells which have been acidized immediately upon their completion the flush production has been merely stimulated. After a certain period of time, upon completion, the curve declines to a point where an acid treatment is indicated.

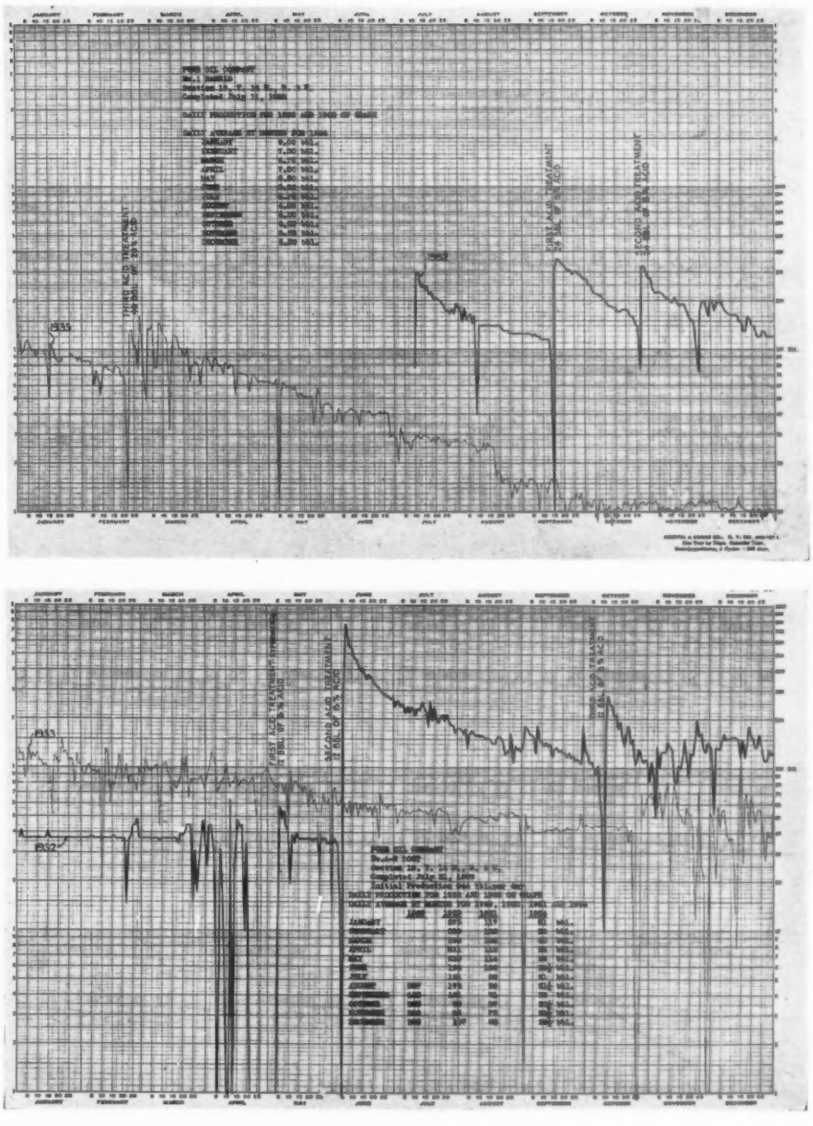
In other words, the wells should be produced until the flush production has been secured, then given an acid treatment which in most cases brings about an upturn in the production curve comparable to the flush. At least one major operator has found that by studying decline curves on their wells, they can schedule their acidizing program so that treatments are given when the production reaches the normal. This method of utilizing the decline curve to schedule acidizing precludes giving treatments too soon or too late in the life of the well. While time has been as yet too limited to arrive at definite con-

clusions as to the increased recoveries due to acid treatment it may be tentatively assumed that Greendale and Porter fields will recover about 20 percent more than they would have recovered without acid applications. This would indicate that of the total ultimate production of 53,150,000 bbl. from Greendale and Porter-Yost fields, as estimated in this article, 8,860,000 bbl. have been added because of the development of the acid treatment practice, thus marking it a major economic development.

Water Encroachment and Disposal

THE WATER encroachment in Greendale and in Porter fields appears to be primarily a question of porosity of Dundee limestone, and as such bears direct relationship to the ultimate recovery of crude oil in various sectors of the two fields. Areas with greatest porosities contribute largest oil wells and begin producing large volumes of salt water very soon after completion even if they are held under back pressure. While it is, of course, desirable to keep salt water production to a minimum, still it may be considered a factor of primary importance in thoroughly flushing the limestone, and areas of the two fields underlain by large volume of salt water under considerable pressures will recover several times more oil than areas producing clean oil without contact with water, as is demonstrated by actual production in the Greendale field.

The Greendale field is comparatively free from salt water, out of its 300 currently producing oil wells only some 70, or 23 percent, make a total of 400 bbl. of salt water per day, 11.1 percent of crude oil production, almost all of it in the more porous East Extension, which proved to be by far the most prolific sector of the Greendale. In the Porter field out of 295 completed producers about 180, 61.5 percent, produce 15,000 bbl. of salt water each day, or about 50 percent of the crude oil production. In the Porter field the original salt water table was at −2,750 ft., but large wells have brought it locally up to −2,720 ft. in a very brief interval of time, which, considering the thin pay zones within the Dundee means in fact a flooded condition. In such areas operators handle wells making 100 bbl. of oil and 500 bbl. of salt water per day, indicating effective water drive and flushing. While in Porter salt water is now confined principally to the lower and the more porous of the two producing zones in the Dundee limestone, which probably interconnect, it will eventually flood and flush the upper zone, though at this time successful plugging up of the lower zone has been accomplished where the salt water production increased to uneconomic levels.



Actual daily production curves of acid treated wells in the Greendale field.

In the Porter field oil and salt water are run into 750-bbl. treating tanks, after addition of treating chemicals in the gathering lines; then gas is taken out through the top of the tanks, while the fluid is forced through 12 ft. of salt water continuously kept in the tank at 135 deg. F.; upon separation oil is taken to 500-bbl. storage tanks and salt water overflows into elevated tanks which are connected with the salt water disposal systems by gravity lines. Pure Oil Company and some other producers deliver salt water into trunk pipelines of the Dow Chemical Company which extracts at its Midland plant, some 12 miles away, from this water bromine, magnesium and other salts, now used extensively in premium ethyl motor fuels, in Dow metal and in other products of the Dow Chemical. Oil producers are not paid for the salt water delivered into pipelines of the Dow Chemical, this method solving the disposal problem in an area where pollution of river waters is highly undesirable because of its location in a resort state with extensive game fish culture. Salt water not taken by the Dow Chemical Company is collected in ponds and is released into the rivers during flood stages, with state conservation officers at all times supervising the release of salt water and testing for safe salinity the river waters.

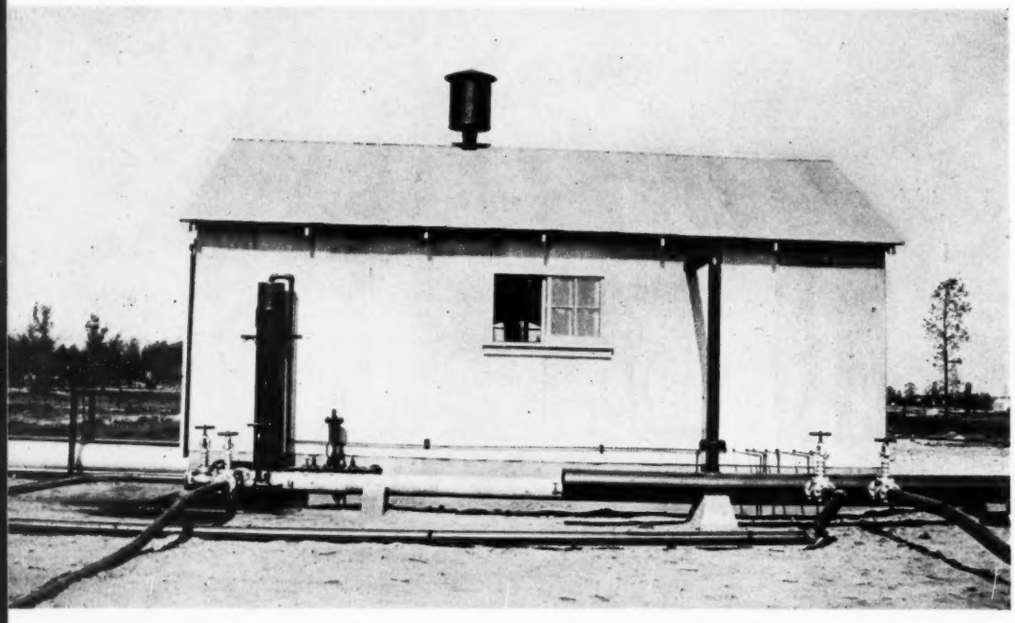
Balance Sheet of Development

THE Greendale and more particularly the Porter fields developed into much

more prolific producers than either of the two earlier Michigan fields, Saginaw and Muskegon. Similarly Greendale and Porter became the first profitable fields in the state, since Saginaw showed considerable loss on its development, while Muskegon barely broke even.

The total capital outlay for drilling and equipment of 681 completed oil wells in Greendale and Porter-Yost has been to date $12,660,000, of which $8,320,000 was in Greendale and $4,340,000 was in Porter-Yost. Additional expense of installing pumping equipment probably averaged $4,000 per well in both fields, thus bringing the total cost of producing wells to $15,380,000, $9,810,000 in Greendale and $5,570,000 in Porter-Yost. A total of 29,967,214 bbl. of crude oil was produced in Greendale and Porter-Yost fields till March 1, 1935, bringing from 37 cents to $1.79 per barrel as indicated on Chart 1. The gross value of oil produced in Greendale field to March 1, 1935, was $14,520,000, or net, after deducting ⅛-th royalty, of $12,710,000; the corresponding figures for Porter-Yost being $12,700,000 and $11,120,000. Direct lifting costs are estimated at 15 cents per barrel or at about $2,600,000 in Greendale and $1,900,000 in Porter-Yost; or a total of $4,500,000, indicating thus a net operating profit to date of $1,790,000 in Greendale field and of $2,280,000 in Porter-Yost, or a total of $4,070,000.

The estimated future recovery of some 23,182,786 bbl., as indicated earlier in this article, should cost to produce about $3,480,000. It may be anticipated that Michigan crude oil will average $1.30 per barrel over a period of next few years and on that basis the future recoverable crude will have a gross value of about $30,100,000, $26,000,000 in Porter-Yost and $4,100,000 in Greendale, or net, after deduction of royalty fraction, of $22,750,000 and $3,588,000 respectively; thus indicating a future net operating profit of $19,750,000 in Porter-Yost and $3,100,000 in Greendale, or a total of $22,850,000.



Engine house equipped with gas engine and compressor serving three pneumatic cylinder pumping wells.

The total indicated net operating profit in both fields over the whole producing life can be therefore approximately estimated at $26,920,000; $22,030,000 in Porter-Yost and $4,890,000 in Greendale. These figures, however, do not include exploration, depreciation and interest charges and general overhead of operations; thus while the development and direct lifting expenses in this summary are estimated to have been to date 57.25 cents per barrel, and will be eventually reduced to 38.90 cents per barrel in Greendale and Porter-Yost fields combined, or 71.8 cents and 62.9 cents in Greendale and 51.1 and 29.0 cents in Porter-Yost respectively, the total all-inclusive cost of production to date can be estimated at about 90 cents per barrel. In figuring balance sheets of individual operators in Greendale and Porter-Yost fields due attention must be paid to their respective holdings in each pool and to their current production which may be considered a good measure of the company's proportionate share of the remaining recoverable reserves.

Pipelines, Refineries and Markets

Two pipeline systems serve Central Michigan oil fields. The Pure Oil Company's 6-inch line connects Greendale and Porter fields with the company's tanker terminal at Bay City on the Saginaw Bay, Lake Huron, from which the oil is moved to the Toledo, Ohio, refining area, where it is refined in the plants of the Pure Oil Company (9,500 bbl. capacity with an 8,000 bbl. Gyro cracking installation); of the Standard Oil Company of Ohio (12,000 bbl. capacity with a 4,500 bbl. Tube and Tank cracking installation); and of the Sun Oil Company (14,000 bbl. capacity with a 6,000 bbl. Sun cracking installation). Pure Oil Company also operates a smaller 3,500 bbl. topping plant at Midland, Michigan, supplying local industries with fuel oil. Pure Oil Company currently handles about 26,000 bbl. of crude oil from Central Michigan fields, of which about 15,500 bbl. are from its own properties, while the balance is being purchased from independent producers. During winter months, when navigation is closed on the lakes, crude oil is shipped to Toledo by rail. Roosevelt-Simrall Pipe Line Company's 4-inch line connects Porter and Greendale fields with the local refinery of the Roosevelt Oil Company at Mt. Pleasant, which is of 5,000 bbl. capacity with a 1,200-bbl. Dubbs cracking unit under consideration; Roosevelt Oil Company purchases most of its oil supply, its own production currently averaging but around 750 bbl. per day. Mid-West Refining Company's plant at Alma of 2,000 bbl. capacity is connected with the Porter field, 12 miles away, by same company's pipeline. Other larger refineries in Michigan running Greendale and Porter crude oil are: Naph-Sol Refining Company of 2,500 bbl. capacity with a 1,100 bbl. Dubbs cracking installation at Muskegon; Old Dutch Refining Company's plant of 3,000 bbl. capacity with a 1,000-bbl. Dubbs cracking unit to be added in the near future, also in Muskegon; and McClanahan Refineries, Inc., plant of 2,500 bbl. capacity in St. Louis, Michigan, and near the Porter field, all these refineries buying their crude oil supplies from producers in the two fields, with the exception of the McClanahan Refineries, Inc., which produces through its affiliated company about 1,200 bbl. per day. In addition to the indicated outlets intermittent shipments of Central Michigan crude oils are made to various refineries in the Great Lakes area, both in United States and in Canada.

Two gasoline plants have been built in Greendale field and one in Porter, of which one in each field is now operating. The O. H. Grimes plant in the Greendale-East Extension with a capacity of 2,500,000 cu. ft. per day is treating currently 1,800,000 cu. ft., recovering 2,800 gallons of natural gasoline per day; while the Porter gasoline plant now processes about 2,500,000 cu. ft. of gas per day recovering around 3,750 gallons of natural gasoline, both plants averaging about 1.55 gallons per 1,000 cu. ft. of gas.

As is shown in Table 3, Michigan crude oils do not produce straight-run gasolines of high anti-knock rating and therefore these gasolines must be reformed to make a marketable motor fuel. Cracked gasolines made from topped crude are, however, of very satisfactory anti-knock rating. When not reformed the straight-run gasolines find wide application as technical naphthas for rubber industry, for cleaning solvents and for many other uses.

Geology—Stratigraphy

THE GEOLOGIC section in Greendale and Porter fields comprises between 250 and 300 ft. of glacial drift material of Pleistocene age; around 50 to 75 ft. of "red" Permian, not present in all wells and still not generally recognized; about 550 ft. of Pennsylvanian deposits; some 1,600 ft. of Mississippian beds; and about 2,400 ft. of Devonian sediments, the main producing formation in Central Michigan, the Dundee linestone, being of Devonian age and encountered about 1,000 ft. from its top and 3,400 to 3,450 ft. below the surface. The deepest wells in Greendale-Porter area have been drilled only to the base of Devonian and hence the following thicknesses are only approximate estimates. The Devonian in Central Michigan is followed by 3,500 to 4,500 ft. of Silurian sediments, which are underlain by Ordovician, with the St. Peter sandstone estimated to be some 500 ft. in the Ordovician, and 9,000 to 10,000 ft. from the surface. Since all wells in Central Michigan are drilled with cable tools, excellent sets of samples are usually available, and with very definite and areally but little changing lithology, correlations are very reliable even if but little care is exercised in collecting and examining the well cuttings. The Michigan Geological Survey in Lansing keeps complete and detailed records of all wells drilled in the state, these records being available to the industry.

The glacial drift of Pleistocene age covers practically all of the Lower Peninsula of Michigan, averaging around 300 ft. in Greendale and Porter area and rapidly thickening to around 1,000 ft. due northwest. This morainic drift has been left by glaciers advancing from the northeast with the axis of advance approximately through the middle of the Saginaw Bay. The drift is composed of sand, clay, gravel and boulders, and where it exceeds 500 ft. in thickness it presents considerable difficulties for drilling. The glacial drift also makes the seismograph work in the state of relatively little value as the velocities vary greatly from location to location, while very small relief of producing areas necessitates very close work.

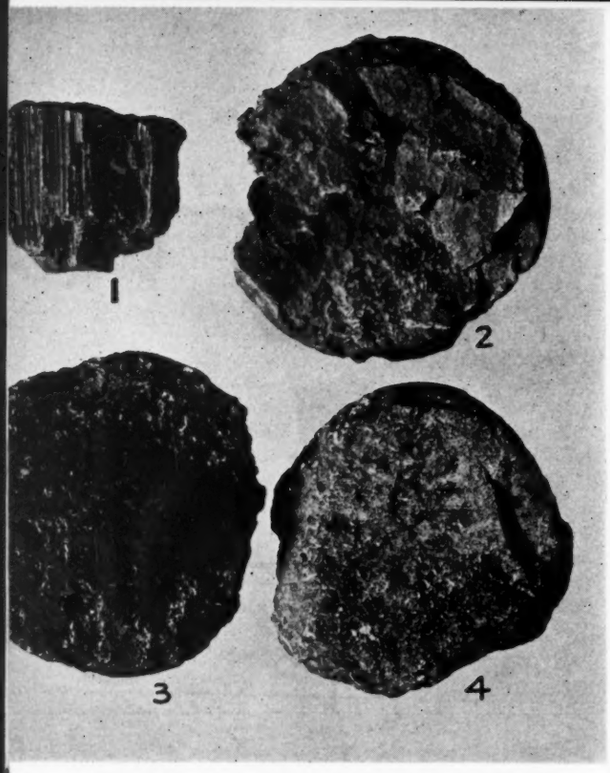
The "red" Permian has not been definitely identified in Greendale and Porter area, but is thought to be present, consisting of 50 to 75 ft. of red shales and sandstones. The difficulty of identification is due to the presence of this section immediately below the glacial drift with which it may be easily confused.

The Pennsylvanian section in Central Michigan, about 550 ft. in thickness, consists of Saginaw dark shales, coals and lenticular sandstones; and of Parma sandstone, which is a white water-carrying sand body varying in thickness from 20 to 100 ft., averaging around 50 ft. None of Pennsylvanian formations can be considered as reliable as the underlying formations for use as key beds in correlation work, having been laid on highly irregular surface of the Michigan series.

Air heater in line leading from engine-compressor house to pneumatic cylinder pumping well.

The first formation of the Mississippian section, which totals 1,600 ft. in thickness, is the Grand Rapids—Michigan, about 300 ft. thick, which is composed of grey and black shales, dolomitic bituminous limestones, anhydrite and gypsum, and lenticular sandstones. A fairly uniform and continuous sandstone at the base of Michigan series, 30 to 40 ft. in thickness, carries locally gas in commercial quantities, and occasionally a little heavy oil; Broomfield, Big Rapids, Vernon and other gas fields are among the more important sources of natural gas from Michigan series. A definite unconformity separates the basal Michigan sandstone from the underlying Napoleon sandstone of Marshall sand and shale series, this unconformity being occasionally suggested by thin gypsum layers. The Marshall formation is about 250 ft. in thickness, with its upper sand member, the Napoleon, averaging about 140 ft. Napoleon sand is the horizon from which the Dow Chemical Company produces heavy brines for extraction of chemicals at its Midland plant. The top of Napoleon sand is the first reliable marker in Central Michigan. The Marshall series are underlain by about 1,000 ft. of uniform grey shales, followed by 20 to 50 ft. of Berea "sand" which in Greendale and Porter area is represented by sandy and calcareous shales, occasionally carrying very minor gas and oil showings.

The Devonian section, 2,400 ft. in thickness, begins with about 400 ft. of Antrim brown to black, in part calcareous, shales, containing abundant pyrite and *sporangites*. The underlying Traverse-Erian group consists: (1) of about 380 ft. of Traverse grey, buff and brown limestone,



Cores of Dundee limestone from Greendale field showing: (1) stylolitic structure of limestone in vertical projection; (2) stylolitic crevace [x] in plane view in non-porous limestone; (3) very porous limestone; and (4) slightly porous limestone.

which contains some grey shales in its upper 50 ft., and which carries gas, oil and salt water in a porous zone occurring about 120 ft. below its top; Traverse limestone is locally of commercial importance in Central Michigan, though in Greendale and Porter fields it has produced only a little oil from a few wells; and (2) of about 230 ft. of light grey Bell shales which become black in the basal 50 ft. Dundee limestone follows the Bell and is the only major producing horizon in the Greendale and Porter-Yost fields, being, where drilled through, around 200 ft. thick. The Dundee is a buff to grey, occasionally cherty and fossiliferous limestone, locally varying from pure limestone to dolomitic limestone and to fairly pure dolomite. Dundee is productive in fairly definite and connected porous zones, with intermediate sections being composed of tight limestone. In Greendale field the first and most prolific porous zone is from 25 to 35 ft. in the Dundee, averaging about 25 ft. in thickness, while the second porous zone is some 60 ft. in the Dundee averaging only 10 ft. in thickness. In Yost field the porous zone is very thin, probably not exceeding 5 ft., and it is encountered about 35 ft. in the Dundee. In Porter field the first porous zone encountered is about 20 to 25 ft. in the Dundee and does not exceed 15 ft. in thickness, averaging under 10 ft., and is probably the stratigraphic equivalent of the Yost pay zone; the second and principal porous zone in Porter field is about 30 to 45 ft. in the Dundee and is also rather thin but extremely porous, in places being in fact cavernous; the second Dundee pay in Porter field is often split into two porous zones, the lower in such instances being the more porous and the more prolific. The porosity of Dundee limestone is definitely due to secondary solution as is shown by cores of the formation on the accompanying photograph. The porosity is of two types: (1) percolating solution type in more easily soluble limestone, forming irregular interconnecting rounded cavities as is shown by core No. 3, these cavities being very often filled with recrystallized calcite and salt; and (2) stylolitic type, forming very thin vertical columnar wave-like fractures, as is shown in vertical projection by core No. 1 and in plane view by core No. 2 (x), by means of which waters probably migrate vertically through less soluble portions of limestone. Stylolitic structures are probably due to slow solution under considerable pressures of resistant hard limestones; at first the dissolved zone is usually refilled with carbonaceous clayey solution material and is not void, but subsequent water circulation under pressure probably causes the clearing of dissolved limestone residue as is shown by stylolitic crevace in core No. 2 (x). While the porous zones within Dundee limestone are thicker in Greendale than in Porter, the total porosity in Greendale is less. This factor plus the absence of salt water results in smaller oil recoveries per acre over most of the Greendale field with the exception of the central portion of the East Extension which showed the greatest recoveries per acre. The Dundee limestone in Porter field is unusually porous and cavernous as was shown by a few wells which attempted to plug back with cement only to find an apparently bottomless void. The variable solubility of limestones may be due to secondary depositional disconformities within it, which is the more probable theory, or to chemical variations in the composition of limestone, or to both these factors. It is believed that the crude oil in Central Michigan is indigenous to the Dundee limestone and is closely associated with primary and secondary unconformities above and within that section, with areal migration of but very limited extent; however, some consider Bell shales overlying the Dundee as the source bed. It is possible that in Central Michigan periods of deposition of Dundee limestone from supersaturated waters were followed by periods of unsaturated waters, in mineral content or climatically, which caused partial and selective solution of already deposited limestone and at the same time organic matter was accumulated in the resulting voids in greater volume than in the primary limestone. Overlying beds, either tight limestones or shales, sealed in the organic matter, which subsequently was changed into oil, while pressure of younger sediments resulted in porosity of stylolitic type, which caused an additional porosity of solution cavity type by vertical migration through tight zones of the limestone. This theory postulates that the greater the solubility of limestone, the greater is the space of accumulation of organic matter and hence the greater the resulting oil reserves and incidentally the greater is the volume of salt water present, provided, of course, sufficient amount of organic matter was locally available. In places where organic matter for some reason was deficient, but porosity was great, oil accumulations of today are very thin and are underlain by large volume of water, as is the case in Vernon pool, which produces at this time 2,000 bbl. of oil and 15,000 bbl. of salt water per day. Inversely areas of small solubility of limestone did not furnish either sufficient space for the accumulation of organic matter, nor enough voids for free circulation of waters, which are locally entirely absent in the Greendale field, and where formerly present, leaving to-day but small residual volume of supersaturated brines or even only salt crystals.

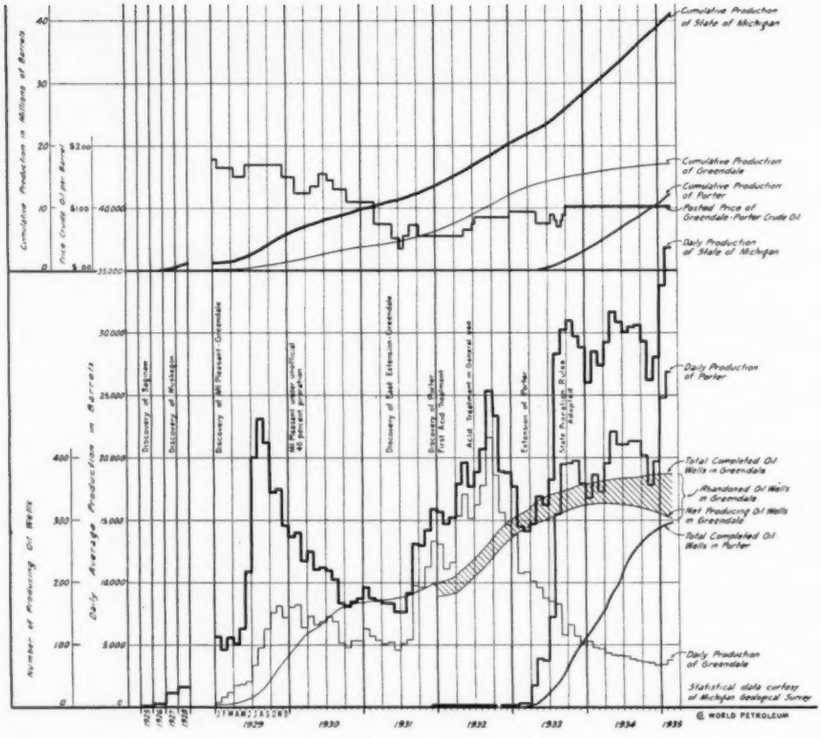
Dundee limestone is underlain by Detroit River dolomites, salt and anhydrite, ranging in thickness from around 300 ft. to over 1,500 ft. with maximum thickness in the center of the basin which in Detroit River time was about 70 miles due northeast from Greendale-Porter area. In Greendale field the Detroit River series are 1,200 ft. thick. The Sylvania dune sands and sandy dolomites follow the Detroit River and are between 100 and 250 ft. thick. The Silurian deposits in Central Michigan consist of limestones, dolomites, salt, gypsum and anhydrite, ranging up to about 4,000 ft. in thickness and marking the geologic period in which lower Michigan first made its appearance as a definite closed basin. The Salina section may be considered as a possible producing oil horizon, having shown oil and gas in few deep wells drilled in Michigan. The underlying Ordovician sediments, including Richmond and Utica grey and black shales, and Trenton limestones and dolomites, precede the St. Peter sandstone, the stratigraphic equivalent of Simpson "Wilcox" in Oklahoma, which, while not yet productive in Michigan, may possibly show commercial accumulations. At this time deeper prob-

TABLE 4

Accumulated and Daily Production and Completed Oil Wells as of March 1, 1935, in Greendale, Porter, and Yost Fields by Companies and Totals

Company	Map Abbreviation	Greendale				Porter				Total			
		Accumulated Production		Wells	Current Daily Product.	Accumulated Production		Wells	Current Daily Product.	Bbls.	Per cent total	Oil Wells	
		Bbl.	Per cent total			Bbl.	Per cent total					Number	Per cent total
The Pure Oil Company		10,098,342	58.00	184	2,000	5,179,868	42.90	129	11,100	15,891,056	52.90	329	46.40
The Pure Oil Company owns all of Yost, having drilled in that field 16 oil wells with an accumulated production to March 1, 1935, of 612,846 bbl. Current daily production is 1,900 bbl. per day													
Branigar, Giffert & Reasor	B.G. & R.	3,683		2						3,683		2	
Brade & Saunders	Br. & S.	213,239		3						213,239		3	
Borland & Travis	B. & T.	347		1						347		1	
Chas. C. Flarida	C. C. F.	16,869		1						16,869		1	
C. F. White et al	C. F. W.					48,354		1		48,354		1	
Chippewa Oil & Gas	Chipp.	398,131		10						398,131		10	
Conoever—Jackson Robbins	C. J. R.	33,110		1						33,110		1	
Carter Lease Inc.	C. L. I.					152,171		6		152,171		6	
Columbia Oil & Gas	Col.	773,465	4.48	17	77	46,755		3		820,220	2.75	20	2.82
J. W. Campbell & Vere Nunn	C. & N.					26,832		1		26,832		1	
C. W. Teater	C. W. T.					170,177		8		170,177		8	
C. W. Teater & Wm. R. Kales	C. W. T. & K.					17,882		3		17,882		3	
Davis Oil Co. & Daily Crude	D. O. & D'ly Cr.					520,767	4.31	8	1,115	520,767	1.74	8	1.13
Dougherty & Markey	D'gh & M.					38,792		2		38,792		2	
Dixie Oil Co.	Dix	379,787		12						379,787		12	
M.D. & R.A. Wells	D. & W.					25,362		5		25,362		5	
E. Brown Oil Dev. Co.	E. Br.	91,111		2						91,111		2	
Edward Stewart	Edw. S.	97,193		5		530,471	4.39	8	623	627,664	2.09	13	1.83
Empire Oil & Rfg. Co.	Emp.					30,804		2		30,804		2	
Felton & Flarida	F. & F.	9,828		2						9,828		2	
Fred W. Turner et al	F. W. T.					303,673		8		303,673		8	
Garfield O. & G. Co.	Garf.					40,052		2		40,052		2	
Geo. Talbot et al	Geo. T.	914,897	5.30	15	222					914,897	3.05	15	2.11
Gol. Graves & Mechling	G. G. & M.	64,599		5		38,519		1		103,118		6	
George Hanners	G. H.					219,699		4	393	219,699		4	
G. Lee P. Oil Co.	G. L. P.	311,859		6						311,859		6	
Gordon Oil Co.	Gord.	484,874	2.81	12		676,325	5.60	22	1,171	1,161,199	3.87	34	4.80
Geo. W. Giffert	G. W. G.	14,124		1						14,124		1	
Hirzel—Leland Dev. Co.	H. L. D.	22,129		2						22,129		2	
J. C. Arthors	J. C. A.	156,918		4						156,918		4	
J. Mark Harvey	J. M. H.					29,230		3		29,230		3	
J. S. Braden	J. S. B.					80,453		3		80,453		3	
Joseph Trevor	J. T.					906		1		906		1	
Jones & Woodruff	J. & W.	53,957		4						53,957		4	
J. W. Leonard, Jr.	J. W. L., Jr.	55,767		4						55,767		4	
Karl Adams et al	K. A.	12,171		1						12,171		1	
Kenjos Oil Corp.	Kenj.	828		1						828		1	
Leonard Oil Co.	Leon.	474,981	2.78	11						474,981		11	
L. G. Thompson et al	L. G. T.	982		1						982		1	
McHugh Ajax	McH. A.					476		1		476		1	
Michigan Gas & Oil Co.	Mich. G.	69,204		2						69,204		2	
Mich. Pacific Oil & Gas	M. P.	43,138		3		98,171		2		141,309		5	
Mid State Dev.	M. St.			1 drlg.									
Mt. Pleasant Oil & Gas	Mt. P.	64,966		5						64,966		5	
Malcolm—Wells & Miller	M. W. M.	45,420		5						45,420		5	
Northern Oil & Gas Corp.	North					347,171	4.63	14	862	347,171		14	1.98
Ohio Prod. & Ret. Co.	O. Pr.	71,826		3						71,826		3	
Otsego Oil Co	Ots.	43,542		3						43,542		3	
The Rex Oil & Gas Co.	Rex					4,352		1		4,352		1	
Richard Hall	R. H.					28,910		3		28,910		3	
Roosevelt Oil Co.	Ro'v'lt					416,702		6	763	416,702		6	
Sias Oil Co.	Sias	538,010	3.11	14						538,010	1.80	14	1.98
Smith Petroleum Co	Sm. Pet.					146,869		3		146,869		3	
St. Anthony Oil & G. Co.	St. Ant.	9,787		1						9,787		1	
Strange & Fortney	St. & F.					543,470	4.30	7	1,250	543,470	1.82	7	0.99
Strange Oil & Gas Co.	St. O.					386,550		8	761	386,550		8	
Stoddard & Darke	Stod. & D.					217,970		4	647	217,970		4	
F. W. Stork Oil Co.	Stork	93,344		10		550,744	4.56	15		644,088	2.15	25	3.53
Sun Oil Co.	Sun					247,244		7	536	247,244		7	
Theodore Oil	Th.	46,235		5						46,235		5	
Thompson Bros.	Th. Bros.	35,106		2						35,106		2	
Vorhees—Schuler & Strange	V. S. & S.	44,803		2						44,803		2	
W. A. Robinson	W. A. R.	108,373		4						108,373		4	
Wellman Oil Co.	Wellm.	12,171		3						12,171		3	
Walter F. Felton	W. F. F.	12,373		1						12,373		1	
W. Hunter Atha	W. H. A.	72,111		3						72,111		3	
W. L. McClanahan Oil Co.	W. L. McCl.	1,283,607	7.43	20	154	911,440	7.55	14	1,058	2,195,047	7.32	34	4.80
Total		17,277,207		391	3,840	12,077,161		302	27,230	29,967,214		709	

Note: The future recoveries of companies operating in Greendale and Porter oil fields can be approximated on the basis of estimated reserves given in Table I. Average future production can be thus roughly calculated on the basis of given company's recovery to date, being 84.3 percent of ultimate in Greendale, 51.6 percent of ultimate in Porter, and 33.1 percent of ultimate in Yost, though companies with but few properties will be influenced entirely by conditions within their localised leases.



Progress development chart of Greendale and Porter fields, Central Michigan, showing daily production, cumulative production, accumulated oil wells and posted prices.

abilities of Central Michigan, below the Dundee, are at best debatable, the St. Peter possibly having not been deposited under conditions favoring the necessary accumulations of organic matter, though paleontological as well as lithological similarity of St. Peter in Michigan with its Oklahoma equivalent, Simpson, is quite remarkable. The search for favorable productive structures in the St. Peter sandstone in Central Michigan, if productive, covered by some 5,000 to 10,000 ft. of younger sediments with at least eight major unconformities and several secondary ones, with Ordovician structures being usually very narrow and small areally, presents in itself an extremely difficult problem. The most recent failure in the St. Peter has been recorded in March of 1935 on the very pronounced faulted Howell structure in Livingston County in the Talbot Oil Company's No. 1 McPherson in section 35, T. 3 N., R. 4 E., which tested salt water in St. Peter at 5,890 ft., still not condemning the Howell anticline as there is at this time no way of determining whether it shifts with the depth or not.

Geologic History and Structure

BOTH Greendale and Porter-Yost fields are, as indicated on the accompanying Dundee limestone structural map, flat and wide anticlines with ragged edges and with but 50 ft. of closure, the accumulation of oil being controlled largely by the porosity of the producing formation. Both fields are located on a general northwest southeast structural trend extending from Clare gas field to Porter, while the individual structures of the two fields themselves trend due east west.

While it is naturally impossible in the brief space available to review in detail the uncertain origin of Greendale and Porter structures, very briefly it may be stated that the lower Michigan synclinal basin, as indicated on the accompanying areal geological map, had its origin in Cambrian or Pre-Cambrian time, possibly being related to the Keweenaw fault, and primarily influenced by the Laurentian massive to the northeast and the Lake Superior geosyncline due north, and to a smaller degree by the Wisconsin land mass due west, the Cincinnati arch due southeast and the Wabash arch due southwest. The original depressing influences coming from the northeast caused parallel warpings, possibly slightly faulted, resulting in trends at right angle to the applied forces, arcuate in shape, with their axis running through the middle of the basin; of these trends the Clare-Greendale-Porter appears very typical. The following sedimentation of the enclosed Central Michigan basin with deposition of great thicknesses of evaporites, limestones and shales probably softened the original relief until to-day such relief is minimal with what is considered very sharp west dip off the Greendale and Porter anticlines ranging to not over 50 to 75 ft. per mile, while closures do not exceed 50 ft. Forces applied in Central Michigan basin, subsequent to its formation, were responsible for additional folding of the original arcuate parallel trends of Clare-Greendale-Porter type resulting in east west cross folds, of which the Greendale and Porter are excellent examples; this being in agreement with the present tendency in the studies of petroleum structural geology of considering intersections of several lines of folding as the most favorable areas for commercial accumulations of petroleum. Certain minor influences further affected the anticlinal structures in Central Michigan in different geological times giving them the present form. Of these the drainage solution of evaporites, salt and gypsum, contributed to the ragged pattern of the edges of structures, while unconformities were responsible for variable thicknesses of individual formations, or even their local non-deposition. The more important unconformities are indicated on the accompanying geological section. In considering the positive structural features of Michigan basin it must be realized that while commercially important, their size and relief is insignificantly small, being in effect but very gentle undulations.

Conclusions

THE Greendale and Porter-Yost fields discussed in detail in this article contributed some 53,000,000 bbl. to the crude oil reserves of the United States, of which about 30,000,000 bbl. have been recovered to date. Both these fields have been important experimental grounds for two major engineering advances within the last two years, the acid treatment and pneumatic cylinder pumping.

Far greater economic significance of Greendale and Porter fields is due to their proving for prolific flush production of a new and but little tested Michigan basin, thus attracting to it the attention of the oil industry. As recently as in April of 1935 a third large pool in Central Michigan appeared to be discovered, about 25 miles due southwest from Porter field, when Leonard Petroleum Company's No. 1 Durbin in section 11, T. 10 N., R. 5 W., in Crystal township of Montcalm County, was brought in flowing 4,200 bbl. per day under 375 lbs. of back pressure from the Dundee limestone topped at 3,189 ft. and drilled to 3,198 ft. Central Michigan thus appears to be on the way to become an important oil producing district of the United States, and while not of outstanding or market-breaking proportions it probably will add a very considerable volume in cumulative production to the country's oil reserves.

World Petroleum Abstracts

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Industry.

Dr. O. W. Wilcox

Petroleum Geology

RECENT DEVELOPMENTS IN GRAVITY PROSPECTING ON GULF COAST.—Olaf F. Sundt, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 1, pp. 19–24.

The Gulf Coast salt domes found by gravity methods since the discovery of Sugarland are reviewed up to and including the recent discoveries.

Besides the better known torsion-balance method, the growing use of the pendulum and gravity meter characterize the last 2 years of gravity prospecting.

Regional surveys destined to reveal the general gravity grain of the Gulf Coast in relation to the isolated salt masses are steadily growing and emphasize the importance of gravity surveys in geophysical reconnaissance work.

ELECTRICAL EXPLORATION ("ELECTRICAL CORING") OF BORE HOLES.—C. and M. Schlumberger and H. G. Doll, in REV. PETROLIFERE, No. 609 (1934), pp. 1525–1530; No. 610, pp. 1557–1562.

The electrical exploration of drill holes is of comparatively recent date, having been introduced in 1928. It depends on the fact that an electric current will pass through water containing electrolytes (salts) in solution. Geological horizons such as clays which have very small porosity and hence contain little water will show a high resistance, while porous horizons such as sands will show a lower resistance. The application of the method is illustrated in the annexed diagram. Three insulated cables, 1, 2, and 3, are lowered into the well; these carry three electrodes A, M, N, which are in contact with the water or mud in the well. The distances A-M and A-N are 10 to 20 times the diameter of the well. Electrode A is connected by cable 1 to one pole of a generator of electric current E, the other pole being connected to an electrode B, which is generally at the mouth of the well. The discharge of current at A creates, by Ohmic effect, a difference of potential between the electrodes M and N, which are connected by cables 2 and 3 to the poles of a potentiometer P, located at the surface of the earth; knowing the distances A-M and A-N and the difference of potential between M and N, the resistance of the earth in that vicinity can be calculated. It should be noted that such measurements must be made in uncased or unlined portions of the hole.

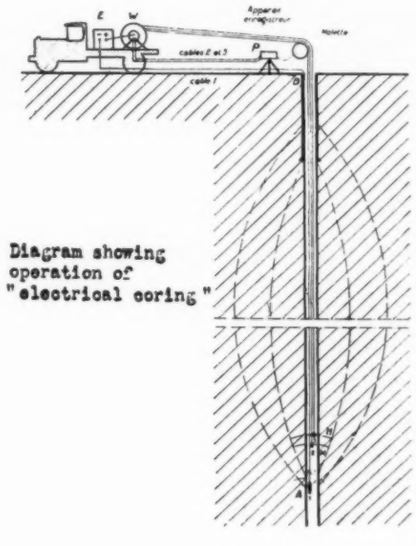


Diagram showing operation of "electrical coring"

This "electrical coring" is held to be fully equal in diagnostic value to mechanical coring, and has the immense advantage of cheapness. Mechanical coring of the entire well is an economic impossibility, but electrical coring can be applied from top to bottom at small expense. Examples are given to show how productive horizons that were unnoticed during drilling have been revealed by electrical coring.

Electrical coring is now applied in practically all wells in Russia and in Venezuela, and is being rapidly introduced into Roumania. The first experiment in the United States was made in 1930, and at the present writing eleven outfits are in use in the oil fields of California, Oklahoma, Texas and Louisiana, and there are one or more in Trinidad, Ecuador, Argentina, Germany, Morocco, and the British and the Dutch Indies.

INFLUENCE OF GEOLOGICAL FACTORS ON LONGITUDINAL SEISMIC VELOCITIES.—B. B. Weatherby and L. Y. Faust, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 1, pp. 1–8.

An examination has been made of velocity data obtained from fifty wells located in eight states. There is definite evidence to show that the velocity of shale and sandstone sections increases with the geologic age of the beds. Less reliable evidence points to a similar relationship for limestone velocities.

The velocity of calcareous sandstones and shales is substantially higher than that of a normal sand-shale section.

There is a definite increase in velocity with depth in the case of shale and sand sections as well as with age.

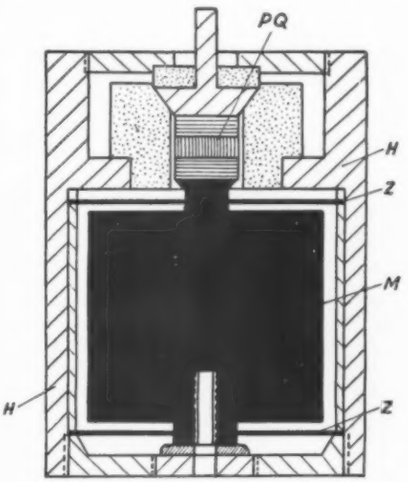
Increase of velocity with age is ascribed to the general increase of the lithification of sediments with age.

OCCURRENCE OF PETROLEUM, GAS AND ASPHALT IN GERMANY.—K. Feige, in KALI, vol. 28 (1934), Nos. 15, 16, 17, 18, 19.

This extensive article is a fairly complete review and extensively documented study of German petroleum geology. Aside from the northwest basin which is the principal seat of the existing German oil industry the valley of the upper Rhein and the northeast basin seem to offer prospects for further discoveries.

A NEW APPARATUS FOR SEISMIC EXPLORATIONS.—Richard Ambronn, in PETROLEUM, vol. 31 (1935), No. 5, pp. 4–8.

The author describes a new apparatus for making geophysical surveys by the seismic method. The new apparatus, which is constructed on the piezo-quartz principle, is diagrammatically illustrated in the accompanying sketch. On the heavy mass M is pressed, by means of a screw, a column of piezo-quartz plates PQ. The whole system is enclosed in a metal box H, and the mass M is kept from side motions by two centering membranes Z, so that the mass M is responsive to wave motions perpendicular to the planes of the membranes. When a wave motion or vibration is produced in this direction it is transmitted to the column of quartz plates, which is thus put under pressure. Since the quartz plates are suitably cut from quartz crystals, the pressure produces a piezo-electric charge which is proportional to the intensity of the motion. This electric charge is discharged through a metallic connection and after being electronically amplified is conducted by wires to a central registering station. The advantage of this arrange-



ment, aside from the simplicity of construction of the receiver, is that a number of these receiving cells can be distributed over the zone to be shaken by an artificial earthquake and connected with a single observing station, thus greatly eliminating the need for a trained observer at each separate station; much time and expense are thereby saved.

Drilling

Pressure Drilling.—Wallace A. Sawdon, in PETROL. ENG., vol. 6 (1935), No. 5, pp. 40–48.

This general article gives a review of the history of pressure drilling and an outline of the present technique of the operation.

Mechanical Equipment used in Drilling and Production of Oil and Gas Wells in the Oklahoma City Field.—Gustav Wade, in U. S. BUR. MINES TECHNICAL PAPER 561 (1934).

The oil-bearing formations in the Oklahoma city field are at an average depth of 6500 feet. This paper presents the results of a study of new equipment developed to meet the requirements in this field. A detailed estimate is given of the cost of a conventional steam-driven rotary outfit for drilling in this field after the derrick has been erected. By subtotals this cost foots up as follows:

Boiler plant	$18,249
Drilling machinery	29,997
Drilling string	58,696
Casing equipment	5,285
Miscellaneous	880
Total cost	$113,107

These costs are based on 1930 prices and do not include a bailer or a bailing line. The total cost of an average well in this field producing from the Wilcox sand through all the stages of natural flow, gas lift and pumping, exclusive of the cost of the drilling equipment, is given as about $141,500.

Based on observation and study in this field the author considers that further development of efficiency in mechanical equipment for the oil industry may well be along the following lines:

(1) The limiting capacity of the draw works depends upon the brakes on the hoist. The brakes are of the friction band type and although the best lining material obtainable is used, their service life is short and the maintenance expense considerable. Water cooling cannot be expected to be adequate for much increase in drilling depth.

(2) There is need for stronger and more durable rotary hose that will still be flexible enough and have an ample factor of safety if it becomes necessary to increase mud pressure much above the magnitude used in this field. Sectional all-steel rotary hose can be made amply strong but has the disadvantage of not being as flexible as is desirable when under pressure.

(3) The large size of steam boilers used in drilling in this field is perhaps more the result of the drilling contractors' ideas of what was required than of the boiler manufacturers' judgment in design. The adoption of superheated steam in oil-well drilling is a logical step of advance. The type of superheater boiler used in this field is somewhat difficult to clean internally. This is a matter of considerable importance, for any point of design that increases the difficulty of cleaning will result in a boiler that will not be kept clean.

(4) Although more a matter of planning than of mechanical design, the orientation of derricks directly influences the placement of equipment so that workmen can get utmost service out of it without exposing themselves to unnecessary hazards. In the Oklahoma City field there is no general practice followed by orienting the derrick so that on tubing and rod-pulling jobs the hoist operator will not be obliged to face the sun in observing equipment hoisted into the derrick. Where terrain permits orienting the derrick in any direction, this point should be considered.

Notes on Barytes Recovery from Muds.—G. H. Scott, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 21 (1935), No. 136, pp. 89–104.

Barytes is now being used in increasing quantities as a weighting material for drilling fluids, and the cost of this material per cu. ft. is a serious item in drilling expenditure. A study of the feasibility of recovering this barytes in a fit state for further service is therefore advisable, and it is such a study that the author here presents. Those interested in the subject will find here much interesting information and practical advice.

Oil Well Operation

Pressure—Time Chart for Cementing Operations.—Wallace A. Sawdon, in PETROL. ENGINEER, vol. 6 (1935), No. 4, pp. 27–30.

In carrying out a cementing job there is a tendency to neglect making a record of pressures and time involved in the operation. This is unfortunate, because these factors have a definite bearing on the success of the job, and, moreover, a permanent record of these will be found of value in planning future repair work. To facilitate making these records there has been developed an automatic time and pressure recording gauge, which indicates the mixing time, the time consumed to pump the cement, and the pressure that is applied at every moment. Any accidents that may occur will show on the chart. When cement is preceded by water there is a record of time required for pumping it down and what pressure was used. There is thus a check on the cementing company's operation. When studied in connection with other well data the chances of success can fairly be determined by the time pressure chart, which becomes part of the well history and will be valuable in future recementing.

The instrument was developed by Martin-Decker Corp. and consists of a recorder and indicating gauge protected by a special pulsation damper, connected to a diaphragm on the manifold of the cementing pump.

Paraffin Accumulations in East Texas Wells.—B. Mills, in OIL WEEKLY, vol. 76 (1935), No. 4, pp. 29–30.

Operation of wells in East Texas has been made more or less difficult by deposition of paraffin on the walls of the tubing. The reason for this is that under certain circumstances paraffin passes out of the solution in the oil on its way to the surface. While still in the formation, the paraffin is held in solution largely with the assistance of the reservoir pressure, conjoined with the relatively high formation temperature. As the oil rises in the tube the pressure is lowered, gas comes out of solution, the oil becomes cooled both by the degassing effect and contact with the cooler region of the well; this accounts for the crystallization of the paraffin. This would not necessarily cause trouble if the oil flowed freely, as then the crystals would be swept along. But when the well is operated on a small choke to avoid exceeding the allowable, the paraffin has an opportunity to settle on the tubing and gradually reduce its diameter.

There are two principal counter-measures. One is to obtain the daily allowable by flowing the well rapidly, as less gas comes out of solution during a wide-open flow. Where this method has been followed little trouble has been experienced; weak paraffinic wells on the pump should be kept full of oil, rather than intermittently full and empty. The second counter-measure is to use a scraping tool consisting of a small wire line, socket, weight or sinker bar, and scraper. One such scraper in a 2½ inch tubing is a round knife 2¼ inches in diameter supported by two fingers in the same position as a bit in a cable tool set. It is necessary to flow the well while using the scraper. In some cases the paraffin has been dissolved out by using gas oil and other solvents.

Drilling in Low-Pressure Formations.—Gh. Calleya, in ANN. MINES ROUMANIE, vol. 18 (1935), No. 2, pp. 70–73.

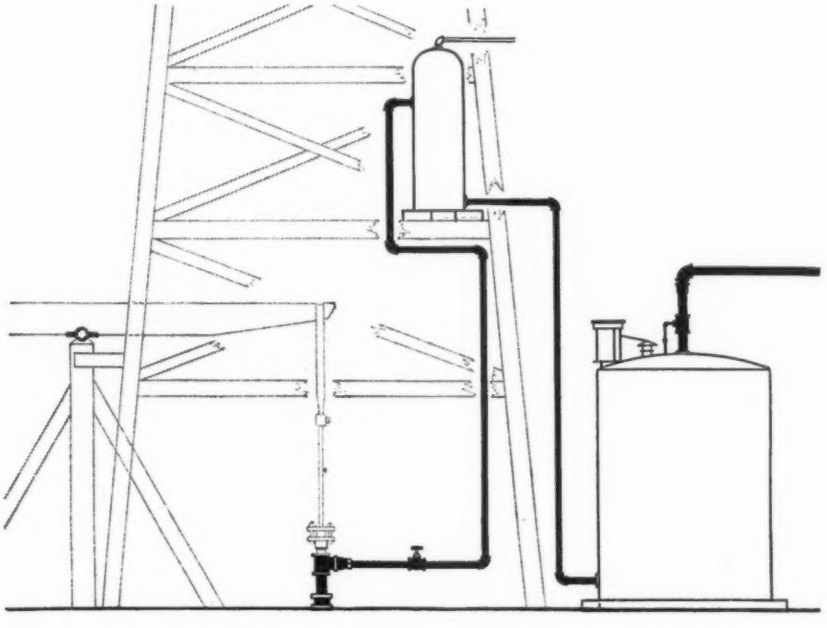
In many oil fields the problem arises of drilling in horizons of low pressure, where the drilling debris cannot be brought to the surface by circulating even the lightest of muds. This condition is generally coped with by the Pennsylvania system or by the much used "California rig." A better system, known as the rotary subsurface circulation method, is described in this paper. In essence it consists in providing the drill stem and tube with check valves so arranged as to allow of slugging the mud to the surface with compressed air.

Controlled Directional Drilling.—J. C. Albright, in PETR. ENGINEER, vol. 6 (1935), No. 4, pp. 21–23.

Controlled directional drilling of oil wells has quite recently been reduced to a practical science and operators can complete their holes at any approximate point reasonably distant from the vertical; one well at the Huntington Beach field, California, was completed with the bottom at a point 4,600 ft. horizontally distant from the derrick floor. The maximum drift angle brought about by directional drilling has been as much as 68 degrees. Directional drilling has been resorted to in order to reach oil horizons under water, or under cemeteries. It has also been used to kill cratered wells that had got out of control.

The essential tool for directional drilling is a knuckle or universal joint from which hangs, at a fixed angle, a "stinger," which is a diamond-point four-way bit of small diameter, above which is a reamer to enlarge the small hole as drilling progresses. Once well started in the desired direction the hole is continued with the ordinary tools used to drill a straight hole. However, the course of the hole must be checked by directional surveys by the camera—compass method.

NOTE.—Directional drilling is also used in the new patented method of "plural drilling" in which two or more wells are radiated from the same derrick.—ED.



FLOW-LINE DEHYDRATOR.—Anon, PETROL. ENGINEER, vol. 6 (1935), No. 4, p. 30.

A diagrammatic sketch (see above) is given of an electric dehydrator which dehydrates cut oil as it is pumped from the well without preheating. It is said to be the first of the kind to operate successfully in California on a flow-line.

After passing an elevated gas trap the oil enters the bottom of the dehydrator. The oil from the well cuts 61 percent emulsion and three percent water; the treated oil cuts 0.6 percent. Production is 400 bbl. gross and current consumption is about 24 kw.-hr. No attention is required except an occasional regulation of the water level.

NEW ROTARY FEED CONTROL.—Anon, PETROLEUM WORLD (Calif.), vol. 32 (1935), No. 2, pp. 30–32.

A description is given of the Brantly feed control for heavy-duty rotary drilling rigs. The principle of this device is the utilization of the tension of the drilling line and the resulting drum line torque to drive a small power pump through a reduction gear. The feeding rate of the bit is governed by adjusting the size of the orifice in the discharge line. This method of feed is found to increase the efficiency of the rig, to make it easy to drill straight holes, and generally contributes to the safety and convenience of drilling operations.

FURTHER PRODUCTION RESEARCH NEEDED.—Gerald L. Hassler, in PENN. GRADE BULL., vol. 11 (1935), No. 2, pp. 2–8.

One of the principal needs of the industry in the Pennsylvania field (and similar fields) is more fundamental research on the laws of oil flow. As an example the author considers a water-flood property and shows how the operation of such a property is hampered by lack of knowledge of fundamental matters. Specifically, what is needed is a thorough investigation of the laws of flow in a clean, stable sand; the effect upon the sand of various conditions of flow, or of chemicals added to the flooding or repressing medium; solutions for problems having to do with the effect of wetting agents; methods for measuring the properties of the sand; various mathematical problems. In the opinion of the author, the Pennsylvania industry, wherein the problem of secondary oil recovery is of great importance, owes it to itself to put a competent research specialist to work on each of these problems.

DRILLING IN THE FITTS FIELDS (OKLA.).—L. G. E. Bignell, in OIL AND GAS JOUR., vol. 33 (1935), No. 38, pp. 10–11; 42.

Interesting details are given of drilling operations in the Fitts field, which is at present among the most active in the country. Producing beds are down as far as 4,200 feet. Thick sections of badly caving shales have been encountered in many of the holes, and this caving cannot be entirely controlled by heavy muds, as the shales themselves are mud-making. Other difficulties are provided by the occurrence of permeable horizons which cause loss of mud returns, and an attempt is being made by one company to incorporate a fibrous material with the mud, with the idea that this material will seal off the mud-absorbing formation.

Natural Gas

NEW FIELD TESTING APPARATUS FOR GAS WELLS.—L. S. Gregory, in OIL AND GAS JOUR., vol. 33 (1935), No. 36, pp. 14–45.

The existing methods and apparatus for testing gas in the field for gasoline content are inadequate. To meet the need both for accuracy and quickness there has been devised a new mobile field outfit which is mounted on a truck or automobile and can be sent to any point desired. This outfit differs from the "test car" in current use chiefly in the completeness of its equipment. The test car meter and compressor are unchanged, but the cooling coils and accumulator are removed and replaced by a specially designed fractionating column. The base of this column is heated by an electric resistance coil drawing energy from the car's battery; the top of the column is cooled by a special refrigerant cycle, the cooling being a 50-lb. block of dry ice, which lasts for a day's operation. In making a test, connection is made to the source of gas, and the compressor delivers the gas to the column at 250 lbs. All condensibles are returned to the bottom of the column and the residue is metered at the top. After a sufficient volume has passed, the column is operated as a batch fractionating column making overhead cuts of ethane, propane, iso-propane and normal butane at suitable temperatures and pressures. The apparatus is cooled and the residue measured. The composition of the gas is then calculated. A full test takes one hour, which represents a considerable saving of time.

LIQUEFACTION OF NATURAL GAS.—J. C. Albright, in REFINER, vol. 13 (1934), No. 12, pp. 441–447.

A description is given of the extensive new natural gasoline plant of the Field Gasoline Corp. of Los Angeles, where 30 million cu. ft. of gas is treated daily. The compressing, absorption and fractionating arrangements are fully described. Liquefied butane for truck use is one of the products.

IMPROVEMENTS IN EFFUSION METHOD FOR DETERMINING THE SPECIFIC GRAVITY OF GASES.—W. E. Kuhn, L. C. Kemp, Jr., and J. F. Collins, Jr., before Am. Chem. Soc., New York meeting, Apr., 1935.

An improved type effusion bottle having a gas volume twice that of the standard bottle has been developed. By employing round burr-free orifice openings of from 0.180 to 0.220 mm. in diameter in plates of from 0.05 to 0.10 mm. in thickness, satisfactory results for routine work are obtained with the improved apparatus with gravity balance correlations

for specific gravities below 1.30. The accuracy is decreased above that figure. Stainless steel was found to be a satisfactory substitute for platinum in making the orifice plates.

Asphalt and Tar

Raising the Throughput of the Asphalt Still. E. Muishkin, in NEFT, Vol. 4, No. 19, pp. 16–18. Foreign Petr. Tech., Vol. 3, No. 1 (1935).

Difficulties encountered in cooling the asphalt during the blowing are met by using kerosene or gas oil together with air. Calculations on heat transfer in this process are presented.

Weathering of Bituminous Coatings, in DE INGENIEUR, 1935, p. 1.

A summary is given of tests used in the evaluation of asphaltic, bituminous and tar coatings for exposed surfaces; the methods used include accelerated tests and outdoor exposures, and are designed to show changes due to climatic influences (especially the effects of light, oxidation, and temperature variations), and any specific properties the material may have, such as tendency to flow at the higher temperatures, and ductility (elasticity) at lower temperatures. The characters of various medium and hard bitumens are described. Moderately blown bitumens are said to be the best for maintaining an unbroken protecting film when exposed to the weather.

Energy Relations at the Interface between Asphalt and Mineral Aggregate and Their Measurements. Charles Mack and R. K. Stratford, before Am. Chem. Soc., New York meeting, Apr., 1935.

The forces acting on the surfaces and at the interface in a system asphalt-mineral aggregate are briefly described with respect to energy of immersion, energy of adhesion, and coefficient of spreading. A method has been developed to measure the interfacial tension between solids and liquids, and experiments extended to a study of the energy relations between asphalts and mineral aggregates. A method is described for measuring the surface tension of asphalts. The coefficients of spreading may be derived from the surface tensions of asphalts and their interfacial tensions against solids. The resistance of asphalt pavement against the action of water is discussed.

Bituminous Material for Pipe Coatings. F. Weckwerth, in ASPHALT UND TEER, Vol. 34 (1935), pp. 1011–1014; 1033–1037; 1053–1055.

This paper is an extended summary of the uses of bituminous material for protecting iron and steel pipes against corrosion and of the methods currently used for applying the coatings both inside and outside the pipes. Air-blown bitumen mixed with suitable neutral fillers is used for internal coatings. Pipes in contact with the soil must not only be protected against rust but also against stray electric currents, which cause electrolytic action. The coatings are tested for electric impermeability by immersing a test piece in a 1 per cent salt solution, connecting it in an electric circuit and noting how the resistance drops. Other tests have to do with the elasticity; there should be a wide difference between the softening and the setting temperature without the bitumen, softening and flowing at maximum summer temperatures, or becoming unelastic at minimum winter temperatures. Asphaltite and asphalt from paraffin-base crudes generally do not possess enough elasticity to meet the requirements. Interior coatings should contain no phenol or other acid substances, and, on the other hand, should not be susceptible to the action of acids or alkalies. An apparatus for measuring the elasticity is described.

Petroleum Refining

Clark Vapor Phase Cracking Process.—J. C. Albright, in REFINER, vol. 14 (1935), No. 2, pp. 43–46.

The Lincoln Clark vapor phase process for cracking petroleum fractions differs from other cracking processes in that heat is directly applied to and mixed in intimate contact with superheated gas-oil vapors instead of being transmitted to them through steel tubes. This paper is a description of the process as carried out by the Rice Ranch Oil Co., Santa Maria, Calif.

Practical Testing of a Continuous Petroleum Still.—A. H. Goodliffe, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 21 (1935), No. 135, pp. 53–74.

This is a practical paper that sets forth the theory and practice of the normal method of testing distilling equipment when first received from the manufacturers. The plant which is the subject of discussion was designed for the production of white spirit and spirits with close boiling ranges of 20° C. or more from the lighter fractions of a variety of roughly topped crudes. The various acceptance tests applied to the apparatus by the author are described and documented in detail, and the results are discussed with the view of assisting designers to produce an economical apparatus both as regards capital expenditure and operating costs.

Gas Solutions; A New Type of Selective Solvent for Petroleum Products.—M. Godlewicz and S. Pilat, in PRZEM. CHEM., vol. 18 (1934), pp. 376–385; Rev. Petrol., No. 619 (1935), p. 243.

When a mixture of propane and methane is used to dissolve an oil, the mixture being under a pressure of 50 atmospheres, the asphaltic constituents are nearly completely precipitated. When the asphaltic precipitate is removed and the proportion of methane increased, the oil may be separated into various fractions having different properties. This is due to the fact that methane is the less soluble in hydrocarbons the greater the molecular weight of the latter. The components of high molecular weight are thus the first to precipitate, then aromatic hydrocarbons, followed by the naphthenes. Other related gases produce similar separations. Hydrogen gas requires much higher pressures to produce the same effect. The method followed by the authors is first to mix the product with propane (the amount required being determined by a test with liquid sulphur dioxide) and then to introduce methane under pressure; the precipitated oil is withdrawn from below. Operating on a Harklow crude they obtained the following products: at 8 atm., asphalt; at 40 atm., the rest of the colored constituents; at 50 atm., an intermediate product; at 70 atm., a heavy oil; at 100 atm., a medium oil, and above 100 atm., a light oil. The various fractions may be subject to retreatment, and may be obtained in a state of purity without acid treatment. It is thought that the process can be developed practically.

Roumanian Crudes and Their Cracking Products.—Gustav Egloff and Edwin F. Nelson, in REV. PETROL, No. 617 (1935), pp. 169–173.

The authors have made a general study of the cracking qualities of Roumanian crude oils. Crudes from the Gurd-Ocnitzei field are relatively rich in naphthenic hydrocarbons and yield gasolines comparable with American products. The Dubbs cracking process is being applied with success.

Pipelines

Nomographic Evaluation of Pipeline Problems.—H. V. Beck, in OIL AND GAS JOUR., vol. 33 (1935), No. 42, p. 46.

Nomographic charts are a great convenience to the oil field engineer, especially in the matter of time saving and avoidance of errors in calculation. The chart here presented connects flow in barrels per hour with viscosity in Saybolt seconds, inside pipe diameter, A.P.I. gravity, pounds per cubic foot, and pressure drop per mile in pounds per sq. in.

Review of Cathodic Protection of Pipe Lines.—A. F. Bridge, in NATURAL GAS, vol. 15 (1934), No. 12, pp. 6–11.

After reviewing the present status of cathodic protection of pipe lines, it is concluded to be a demonstrated fact that a negative potential of 0.2 volt (net), pipe to soil, will effectively prevent corrosion. There is also some evidence that negative voltage of any magnitude will be of value. However, laboratory tests show that negative potentials exceeding 1 volt cause loss of bond between pipe metal and thin bituminous coatings when the adjacent metal is bare. Actual drainage experience indicates that this action, if present at all under field conditions, does not impair coating resistance; furthermore, drainage projects can be eco-

nomically designed for a wide range of conditions without exceeding 1 volt across the coating.

Unit electrical resistance of the bituminous coatings in general use varies widely with age and porosity, and this variable is by far the most important factor influencing the cost of cathodic protection. Resistances of such coatings several years after installation on one gas system range from 134 to 16,000 ohms per sq. ft., and corresponding annual costs of drainage are $258 and $7 per mile respectively.

Ultimate economic success of cathodic protection frequently depends on preventing *continued* deterioration of coating after drainage is applied. Experience to date indicates that for coatings several years old when drainage is started and which have therefore reached equilibrium in water absorption, deterioration is arrested by drainage. This opinion is based on observation of coating resistance. However, information on the point is meager. But provided that this tentative conclusion is correct cathodic protection of lines traversing corrosive soils will often effect very handsome savings over the alternative program of coating repair and renewal.

Field Tests of Rubber Pipe Line Coating.—Frank H. Love, in PETROLEUM ENGINEER, vol. 6 (1935), No. 6, p. 35.

For several years the Goodrich Company of Akron, Ohio, has been making researches to discover rubber-compounds that could be used successfully as a pipe line coating. Some of these compounds have withstood a severe 2½ years test supervised by the U. S. Bureau of Standards and lately two sections of pipe line have been laid down in notoriously corrosive soil in Texas.

Petroleum Chemistry

Comparison of Crude Oil Analyses.—W. Tirospolsku, in PETROLEUM, vol. 30 (1934), No. 51, pp. 1–3.

The physical properties of the crude oil and the productivity of an oil well can be scientifically judged only when the composition of the raw oil and its content of condensible gas are known. Theoretically the boundary between liquid and gas is between butane and pentane. When only the properties of the liquid portion of the crude are known, as is usually the case, comparable data may be obtained when the lighter fractions are excluded and the composition of the stable residue is reported.

Sweetening of Gasoline with Alcoholic Alkali and Sulphur.—B. A. Stagner, in IND. ENG. CHEM., vol. 27 (1935), No. 3, pp. 275, 277.

It has been known for some time that when elementary sulphur and mercaptans are brought together in solution in gasoline in intimate contact with a very small amount of an alcoholic solution of anhydrous alkali, they react instantly with each other; and if proper proportions of the sulphur and mercaptans are brought together under this condition, they are both totally eliminated as such. No lead is required. It is thus possible to remove mercaptans from gasoline by adding the requisite amount of elementary sulphur and anhydrous alcoholic alkali solution, or to remove elementary sulphur from gasoline by adding the requisite amount of mercaptans, or preferably a definite amount of gasoline which contains mercaptans, and the anhydrous alcoholic alkali. Frequently a refinery may have one type of gasoline bearing elementary sulphur and another type bearing mercaptans. A proper blending of these two types agitated with water-free alkali will free the mixture of both substances.

It is found to be much more economical of time and reagent to apply the anhydrous alkali in solution in alcohol, preferably methanol. The alcohol serves to disperse the alkali throughout the gasoline in a fine state of division, doubtless molecular; and the alkali, if added in the minimum amount, is almost completely exhausted in the reaction with the sulphur and mercaptans. The quantity of alcoholic alkali solution required is dependent on the degree of sourness of the gasoline, but it is surprisingly small—one pint per barrel in a typical California cracked gasoline.

The essential reaction is that on oxidizing the mercaptans by sulphur, the mercaptans are converted to alkyl disulphides and the sulphur to alkali sulphide; 50 percent of the original caustic soda is converted into sodium sulphide and 25 percent into sodium thiosulphate, both of which are merchantable by-products. The sweetened gasoline is sufficiently stable in color for most purposes but may be given an acid wash or treated with an acid anti-oxidation catalyst. Any excess of alcohol may be washed out. In contrast with the plumbite method, sweetening with alcoholic alkali and washing with water does not produce emulsions.

Determination of Carbon and Hydrogen in Bituminous or Pyro-Bituminous Shales.—H. W. Hoots, A. L. Blount and P. H. Jonez, in BULL. AM. ASSOC. PETROL. GEOLOGISTS, vol. 19 (1935), No. 2, pp. 293–295.

The analysis of bituminous or pyro-bituminous shales, especially if they contain sulphur and halogens, requires a special arrangement for the determination of carbon and hydrogen by the Liebig combustion method. The authors describe such an arrangement, which also includes an arrangement for determining simultaneously water of crystallization and combination.

A Pure Hydrocarbon Standard for Evaluating Inhibitors.—C. G. Dryer, C. D. Lowry, Jr., Gustav Egloff and J. C. Morrell, in IND. ENG. CHEM., vol. 27 (1935), No. 3, pp. 314–318.

Research of gasoline inhibitors has been handicapped by lack of a standard method of comparison, a lack which the authors have now supplied. The difficulty heretofore has lain in the practice of testing inhibitors in a gasoline, but as gasolines differ among themselves it has not been possible to obtain satisfactory comparison. This difficulty is removed by basing the comparison on a standard gasoline which is reproducible and uniform at all times. After trying a number of hydrocarbons the authors finally selected cyclohexene, which is easy to prepare within a boiling range of less than 0.1°. It has an average induction period of 45 minutes (plus or minus 5 min.), and when free from peroxides gives reproducible induction periods with inhibitors, and is recoverable for re-use by a steam distillation (leaving a 10 percent residue). Knowing the induction period of the standard, the induction period of a gasoline mixture can be given a definite numerical expression, and the efficiencies of different inhibitors can be compared on the same basis.

As a measure of the effectiveness of gasoline inhibitors the authors propose the "cyclohexene number," which is defined as the calculated increase in the induction period of cyclohexene which 0.002 percent by weight of an inhibitor would produce, the calculation being based on the induction period experimentally determined in a secondary reference gasoline which has been related to cyclohexene by the use of alpha-naphthol.

Cyclohexene numbers are given for 41 representative inhibitors, of which a few are given below.

Cyclohexene Numbers

	Solvent	Induction Period[a] Min.	Cyclohexene No.[b]
No inhibitor	....	130	..
Inhibitors, 0.01 %:			
p-Aminophenol	Hexone	1530	1400
2-Amino-5-hydroxytoluene	Hexone	1150	1020
Benzyl-*p*-aminophenol	Hexone	1065	935
p-Hydroxyphenylmorpholine	Hexone	1065	935
Dibenzyl-*p*-aminophenol	Hexone	1045	915
Pyrogallol	Hexone	975	845
1,5-Dihydroxynaphthalene	Hexone	950	820
Catechol	Hexone	875	745
α-Naphthol	Benzene	740	610
2,4-Diaminodiphenylamine	Hexone	730	600
p,p'-Diaminodiphenylamine	Hexone	725	595
Thiodiphenylamine	Benzene	665	535
p-Phenylenediamine	Hexone	605	475
o-Aminophenol	Hexone	545	415
p-Aminodiethylaniline	Benzene	455	325
o-Phenylenediamine	Hexone	440	310
Hydroquinone monomethyl ether	Benzene	410	280
4-Chloro-2-aminophenol	Hexone	330	200
4-Hydroxy-1,3-dimethylbenzene	Benzene	315	185
m-Aminophenol	Hexone	315	185

[a] With Pennsylvania secondary standard I.
[b] Induction period increased, in minutes.

Manufacture of Alcohols and Esters.—Benjamin T. Brooks, in IND. ENG. CHEM., vol 27 (1935), No. 3, pp. 282–288.

The effect of pressure in promoting the absorption of ethylene in sulphuric acid is shown. The formation of ethyl ether by the reaction of diethyl sulphate and ethyl alcohol, and the state of our knowledge of the chemical reactions involved in producing alcohols from olefins is reviewed. Hydrolysis of these sulphates is rapid in acid solutions; in alkaline solutions they are relatively stable.

The author goes extensively into the subject and his conclusions are both interesting and important in relation to the production of synthetic alcohol in competition with alcohol from molasses.

Synthetic Alcohols and Related Products from Petroleum.—Benjamin T. Brooks, in IND. ENG. CHEM., vol. 27 (1935), No. 3, pp. 278–282.

Synthesis of useful materials from petroleum and oil gas has become an important American industry during the past decade; being built on the utilization of a bountiful supply of raw materials from cracking processes in gasoline

manufacture, the new industry has a broad base also in the great variety of products it can turn out. At present the chief interest is in the synthesis of alcohols; one company is producing a series of alcohols and related derivatives from the still gases of a pressure cracking operation; another makes ethylene glycol and ethyl alcohol from the by-product gases of a vapor-phase cracking plant. All these syntheses depend on using olefines, and the cheapest source of the simple olefines is cracked oil gas. This paper presents new data on the yield and composition of gas made by vapor-phase cracking at temperatures higher than are used for maximum gasoline production.

Petroleum Physics

Pressure—Volume—Temperature Relations for Fractions of an Oil.—R. B. Dow and M. R. Fenske, in IND. ENG. CHEM. vol. 27 (1935), No. 2, pp. 165–168.

This investigation on the physical properties of lubricants at high hydrostatic pressures was prompted by the special research committee on lubrication of the A.S.M.E. In order to demonstrate the dependence of some of the thermodynamic properties on composition for a hydrocarbon oil, a light mineral oil from a mid-continent source was distilled and the fractions or cuts were examined at normal and high pressures. The relations discovered are exhibited in tables and diagrams.

Entrainment in Plate Columns.—I. K. Sherwood and F. J. Jenny, in IND. ENG. CHEM., vol. 27 (1935), No. 3, pp. 265–272.

New data are presented on entrainment in a bubble-cap column, using air and water. The results show clearly the effect of gas velocity, plate spacing, and liquid level. An effect of "slot velocity" as well as superficial velocity is evident.

An analysis of the effect of entrainment on column performance is presented, including treatments of the effect of entrainment on both fractionation efficiency and the appearance of color in the distillate. Sample calculations show the effect of entrainment of less than 0.1 mole liquid per mole vapor to be negligible in most ordinary cases.

Determination of Plate Efficiency in Fractionating Columns.—A. J. V. Underwood, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 21 (1935), No. 136, pp. 125–131.

This paper outlines a method for carrying out a test on a distilling column in operation in order to ascertain the efficiency of each plate for all components of the mixture, the method not being limited to mixtures the components of which follow Raoult's Law. The procedure of the test is summarized as follows:

(1) Determine the amounts, compositions, and heat contents of the feed, distillate, residue, and any sidestreams.

(2) Determine the pressures at the top and bottom of the column and find the pressure on each plate on the assumption of a linear variation through the column.

(3) Determine the heat absorbed in the reflux condenser and the heat supplied to the column in the kettle or at other points.

(4) From the data in (1) and (3) a heat balance can be obtained for the whole column, and the radiation loss found either from this balance or by calculation.

(5) Determine the temperature on each plate and the composition of the liquid on each plate by analysis. In the case of petroleum products this would be a true boiling-point analysis. In columns of large diameter, the composition of the liquid may vary from point to point on a plate, and samples should be drawn off at points which will indicate representative compositions.

(6) By the methods which have been described in the paper, calculate the composition of the vapour rising from each plate.

(7) Determine, from equilibrium data, the composition of the vapour which would be in equilibrium with the liquid on each plate. In the case of petroleum products the equilibrium data could be obtained by using Raoult's Law with suitable correction factors determined experimentally for the particular products under consideration.

(8) From (6) and (7) the efficiency of each plate for each component of the mixture can be calculated.

New Design Calculation for Multicomponent Rectification.—E. R. Gilliland, in IND. ENG. CHEM., vol. 27 (1935), No. 3, pp. 260–265.

A new design method for the distillation of multicomponent mixtures is proposed. The calculations are based on the use of "relative volatility" and "relative operability" of the components in the mixture. The procedure is rapid and simple, and for the condition of infinite reflux the calculation reduces to Underwood's modification of Fenske's "relative volatility" system. For the case where separation between adjacent components is not relatively complete, the determination of suitable design conditions by previous design methods has been tedious. The proposed procedure offers a valuable method for facilitating such calculations. The method is useful in determining the proper design conditions, such as dependent terminal concentrations and number of equilibrium plates. The applicability of the method is demonstrated by illustrative problems.

Petroleum Products

High Pressure Lubricants.—E. H. Kadmer, in OEL U. KOHLE, vol. 11 (1935), No. 7, pp. 116–118.

The resistance of a lubricant to pressure is due to the presence in it of constituents which have the property of adhering to metallic surfaces in certain definite directions; the molecules of such a substance thus form a "pavement" of systematically "oriented" molecules that in effect constitute a sort of durable film to which the other constituents of the lubricant adhere better than to the clean or blank metal. Such "cushion-forming" elements of a lubricant that seem to have a special affinity for metal are called "polar" or sometimes "dipolar" substances. It is now generally agreed that the most "surface-active" constituents of a lubricant are those hydrocarbons that have methyl-groups at the ends of their molecules and otherwise have the character of substituted olefines. The character of the substituting group is of importance largely from the standpoint of corrosiveness; oxygenated and sulphur groups may confer high lubricity but may give rise to corrosion of the metal. Much less harmful are the chlorine-substituted dipolar substances and this fact is being now taken advantage of in the preparation of high pressure lubricants.

The efficiency of graphite as a lubricant is due to the fact that the molecules of graphite are highly dipolar as regards metal surfaces, but the practical efficacy of graphite for this use depends on the completeness with which it has been reduced to the colloidal form. This paper gives a number of references to recent journal and patent literature.

Applied Methods and Equipment for Reducing Evaporation Losses of Petroleum and Gasoline.—Ludwig Schmidt, in U. S. Bureau of Mines Bull. No. 379 (1934).

In this bulletin of 160 pages, with 63 illustrations, the author covers the whole subject of evaporation losses in the handling of crude oil and gasoline. Although at present it is estimated that evaporation losses of crude oil from well to refinery is only about two percent, they are still enormous and might well be further reduced. The author reviews the devices and patented appliances employed for avoiding evaporation losses, and reduces them all to six categories; vapor-tight tankage, vapor recovery systems, floating roofs, breather-bags and breather tank-roofs, removal of lighter fractions, application of pressure high enough to prevent breathing losses. Various auxiliary methods are cooling, insulating and light-colored paints. Among these preventive means vapor-tight tanks deserve a prominent place, as they also reduce the fire hazard and make it possible to secure fire insurance at low rates.

Addition of Colloidal Graphite to Lubricating Oils.—V. S. Prever, in RIV. ITAL. PETROL., vol 3 (1935), No. 1, pp. 3–6.

Experiments have verified the theory that particles of colloidal graphite in lubricating oils adhere by electrical attraction to the metallic surface of bearings, forming a cushion or film one molecule thick. Addition of 0.2 percent of colloidal graphite is as efficient as addition of 5 percent of polymerized castor oil.

Petroleum Products as Horticultural Spray Materials.—Hubert Martin, in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 20 (1934), No. 134, pp. 1070–1090.

The results of laboratory and field trials are quoted to show that when applied to dormant trees, petroleum oil sprays kill insects and their eggs regardless of the base of the oil, its viscosity (128–870 secs. Redwood at 70° F.), its degree of refinement represented by unsulphonated residues of 60–100 percent by volume, or the type of emulsification. When used on leaves the oil must be highly refined and have a high viscosity. The efficacy of an oil spray decreases as the stability of the emul-

sifier is increased. Petroleum oils increase the efficiencies of companion insecticides in proportion to their sticking and spreading properties. The naphthenic acids have been found unsatisfactory as soap substitutes.

CAUSES OF DETONATION IN PETROL AND DIESEL ENGINES.—G. D. Boerlage and W. J. D. Van Dyck, in JOUR. INST. PETROL. TECHNOLOGISTS, vol. 21 (1935), No. 131, pp. 40–52.

This is a record of an investigation carried out for the Bataafsche Petroleum Mij. The combustion phenomena of Diesel and petrol engines are similar in many ways. Self-ignition of the charge in both depends on the interaction of activated oxygen and activated hydrocarbon molecules. "Detonation" may occur in both types of engine, and is due to the vibration of the gases caused by local rapid change of pressure (pink). A "pink" may also be produced by mechanical vibration of the walls due to the high rate of change of pressure. Vibration of other engine parts may produce the "knock." "Rough," or "bumpy running" denotes vibration of heavy engine parts, such as the crank-shaft.

Petroleum Substitutes

WOOD AS SOURCE OF ENERGY FOR VEHICLES.—Bruno Muller, in CHEM. ZTG., vol. 59 (1935), No. 7, pp. 76–77.

In view of the recent introduction of automotive vehicles powered by the gas producers called "gasogens," it is calculated that one-fourth of the annual "slash" left to rot in German forests would suffice to operate all the 150,000 trucks now used in Germany, allowing each an annual run of 20,000 miles. Tests have shown that such power is less expensive than Diesel power under present price conditions.

SYNTHESIS OF OIL FUELS AND LUBRICANTS FROM CARBON MONOXIDE AND HYDROGEN.—F. Fischer, in BRENNSTOFF CHEMIE, vol. 16 (1935), pp. 1–11.

An outline is given of the synthesis of oils as now established by the processes of the author and his collaborators, using carbon monoxide and hydrogen as they occur as water-gas. The results of this synthesis depend very much on the conditions of operation. Increase of pressure (above atmospheric) results in the production of alcohol; increase in the proportion of hydrogen gives more methane, whereas reducing the hydrogen favors the production of olefines; increasing the temperature produces methane and carbon; the choice of catalyzer in the order Fe, Co, Ni, CO plus thorium increases production of saturated hydrocarbons and diminishes the olefines; production of gasoline increases with age of catalyzer at the expense of the heavier oils; the presence of CO_2 is without influence. A good raw material is methane, which is first transformed into a mixture of CO and H_2. At present the yield is 100–120 grams of oily products per cubic meter of gas weighing 180 grams, and it is probable that this yield can be improved. The crude product is a mixture of gasoline (60 percent), heavy oils (20 percent) suitable for Diesel engines, some very pure paraffin, and reaction water. The article closes with a bibliography covering the period 1926–1934.

NOTE.—Considering the vast wastage of non-condensible hydrocarbons in the United States this synthesis might appeal to those interested in natural gas conservation and utilization.—ED.

COAL GAS AS MOTOR FUEL.—Muller, in CHEM. ZEIT., vol. 58 (1934), No. 101, pp. 1020–1021.

In the Ruhr district, Germany, gasoline commands a high price, whereas on account of the local coke industry there is an abundance of coal gas rich in methane. This conjunction of circumstances has led to an extensive substitution of compressed coal gas for gasoline in the operation of motor vehicles, from 5-ton trucks down to motor cycles. The gas is compressed to 2,250 lbs. in steel cylinders attached to the vehicle, from which it is fed to the motor through two pressure reducing valves. Operating experience is said to be quite satisfactory.

NOTE.—Meanwhile millions of cubic feet of the same character of fuel are being wasted daily in the United States.—ED.

Petroleum Economics

OIL TRADE OF LITHUANIA.—L. Brachman, in MONITEUR PETROLE ROUMAIN, vol. 36 (1935), No. 1, pp. 35–39.

The population of Lithuania is about 2,000,000 of which fully two-thirds are engaged in agriculture; the country has no mineral oil resources. Four companies supply the oil market: Shell, "Apekol," "Latrus" and "Levitas." Imports come mostly from the U. S., England, Poland, Roumania and Curacao; imports from Russia are small, due to tariff differentials. Imports of gasoline increased tenfold from 1924 to 1931; the 1933 imports were only 44 percent of the 1931 figures, but this marked drop has not been due to a decreased consumption of motor fuel but rather to the enforced consumption of motor-alcohol. By law of 1931 all motor spirit must contain 33⅓ percent of anhydrous alcohol in winter, and 50 percent in summer (these proportions are about the highest in the world). The business is a government monopoly.

IMPORTANCE OF THE PETROLEUM INDUSTRY.—Edit., OIL & GAS WEEKLY, vol. 33 (1934), pp. 8–10.

With the exception of agriculture, the petroleum industry is the most extensive component of the economic life of the United States. The total annual pay roll is 2,043 million dollars, purchases of material and services from other industries are estimated at 1,312 million dollars, and the annual tax contribution to governmental bodies is put at 1,004 million dollars. Leases, rentals and royalties to the extent of $201,845,000 a year are paid to farmers. Taxes paid in 1933 have averaged $1.11 per bbl. of crude oil, while the average price of crude oil during that year was only 67 cents. The number of persons employed in the petroleum industry is estimated at about 1,250,000; employment in the industry has been sustained at a high level during the business depression and was increased under the petroleum code by approximately 300,000 persons. Stockholders of oil companies have not benefited proportionally, the average net earnings during the past 13 years have been 1.66 percent on the total investment. These total net earnings for the 13 years are only twice as much as the industry's taxes for the single year of 1933. It is estimated that during 1935 the industry will expend more than $500,000,000 for drilling wells and reconditioning and replacing equipment; this estimate excludes ordinary operation and overhead.

GERMAN MOTOR-FUEL SELF-SUFFICIENCY.—Sydney B. Redecker, in OIL WEEKLY, vol. 76 (1934), No. 1, pp. 31–32.

The new national plan for the German oil industry, now in its first stages of development, contemplates raising the output of the Leva hydrogenation works to 350,000 tons of synthetic gasoline. The brown-coal producers are being organized into a joint cooperative which will contribute another 400,000 tons. To this will be added 350,000 tons of benzol from the Ruhr cokeries and 150,000 tons from lignite distilleries and from domestic petroleum reserves, making a total of around 1,250,000 metric tons. By the enforced mixture of 10 percent of alcohol to motor fuel the grand total of production will be raised to close to 1,400,000 metric tons. A further possible source is hydrogenation of stone coal, as distinguished from brown coal. This latter project has not yet passed the experimental stage, but is considered promising. The Diesel oil problem is at present more difficult of solution than that of light motor-oil. Promising substitutes are anticipated through the use of wood in "gasogenes", and methane, propane and butane.

THE OIL MARKET OF TRIPOLI.—A. M. Morgantini, in MONITEUR PETROLE ROUMAIN, vol. 35 (1934), No. 24, pp. 1583–1592.

Tripoli, the Italian dependency on the African shore of the Mediterranean sea, contains slightly more than half a million inhabitants and is in an active process of economic development, assuring an increasing market for all kinds of petroleum products, except perhaps for a decrease in the use of lamp oil in the cities, due to increasing use of coal gas. At present the market is entirely in the hands of three concerns: Azienda General Italiana Petroli, Societa Italo Americana pel Petroli and the Societe Egyptienne des Petroles. However, the future prospects of non-Italian products depends on the fiscal policy of the Italian government; at present oil products of Italian origin enjoy a slight tariff advantage which may be increased at any time.

THE PETROLEUM DEPOSITS OF ARGENTINA.—Tralan T. Serghlescu, in MON. PETROLE ROUMAIN, vol. 36 (1935), Nos. 1 and 2, pp. 11–20; 91–98.

The author reviews quite comprehensively the historical, geological, technical, economic and legislative aspects of the Argentine oil industry. The industry here is somewhat unique in that while private oil enterprises are not excluded, the business is mostly owned and

operated by the government. Argentina still imports much oil but domestic production is increasing and imports show a corresponding decrease. Both the private and the government enterprises are in healthy financial condition. There are 332,000 automobiles in the country.

There are now six producing districts: Oran (Salta), the three adjacent fields Cachenta, Sosneado and Tapungato (Mendoza), Plaza Huincul (Nequen, Mendoza), and Comodoro Rivadavia (Chubut), the latter at present being the most important. The paper is well documented and illustrated with maps, the geology of each field is succinctly described. There is much indication that the industry is far from the possible peak of its development.

THE PETROLEUM POLICY OF VENEZUELA.—Claudio Urrutia in LA IMPARCIAL. (Dec. 26–27, 1934.)

During the past six years Venezuela has produced an average of about 115,000,000 bbl. of oil. The annual disbursements in the country by the companies on production account is above $36,000,000 of which the national treasury receives about $8,900,000; the difference, about $27,000,000, takes the form of wages and disbursements for general expense; less than 50 percent of the cost of a barrel of oil represents overhead. On the other hand, oil exports bring into the country more money than all other exports combined, and this money amounts to 22.5 percent of the national revenue from all sources. For every dollar of revenue the government receives from oil, the companies spend three in the country.

Of late there has been much local demand for nationalization of the Venezuelan oil industry in order that the government may itself enjoy the profits. But aside from the question of successful government production and marketing, to compensate the companies for their investments would require the issuance of $352,000,000 in bonds, which would charge the annual budget with $18,000,000 for interest; such an operation is now a financial impossibility.

Books

RIGBUILDING. By R. C. Paget, A. M. Inst. P. T. Published (London) by: Williams and Norgate, Ltd. (Price: 10s. 6d.)

Despite the advance in the use of steel derricks during the past decade, it is the firm belief of the author that the wood rig will remain in favor for many years to come. With this in mind, he has just produced a handbook, primarily intended for the engineer or driller who is not a professional rigbuilder and who has sufficient lumber available to build a rig.

Mr. Paget, with his wide experience, has been able to go into every detail of the construction, even to the spacing of nails. He does not deal with special foundations such as on lakes, seacoast, or marsh, as they would come under the heading of contraction rather than rigbuilding. The book is well illustrated with photographs, and contains many charts, diagrams, tables, and mathematical formulae which are calculated to simplify the work of the amateur rigbuilder. As it is understood to be the first book published on this subject, it will no doubt find a ready place on the shelf of the expert, also.

PETROLEUM INDUSTRY AND TRADE IN FRANCE (L'INDUSTRIE ET LE COMMERCE DES PETROLES EN FRANCE), by Henry Peyret; Paris: Soc. d'Etudes et d'Informations Economiques, 79 pp. 7 fr. 50.

The author discusses sources of French petroleum supplies, their distribution, and the petroleum policy of the French government.

PROBLEMS OF PETROLEUM GEOLOGY: A SEQUEL TO STRUCTURE OF TYPICAL AMERICAN OIL FIELDS.—A symposium edited by W. E. Wrather and F. H. Labee, and published 1934 by Am. Assoc. Petroleum Geologists, Tulsa, Okla. $6.00.

This is the third volume of a series on the fundamentals of American petroleum geology. The two volumes previously issued relate to the structure of typical oil fields. The present volume deals with problems of a general nature, including: origin and evolution of petroleum; migration and accumulation of petroleum; relations of petroleum accumulation to structure; porosity, permeability and compaction; oil field waters, and sub-surface temperature gradients. Each subdivision of the general theme is treated by a specialist.

MODERN IDEAS ON FUELS, LUBRICANTS AND LUBRICATION (Les Idees Modernes sur les Carburants, les Lubrifiants et la Lubrification), by Horace Havre; Paris: Librairie Polytechnique Ch. Beranger., 267 pp., 28 figs., 10 plates. 50 fr.

A treatise on the construction and use of internal combustion motors, with special reference to the use and abuse of fuels and lubricants.

GEOPHYSICAL PROSPECTING, 1934.—Published by American Institute of Mining and Metallurgical Engineers, New York; 583 pages.

This volume is a collection of all the papers on geophysical methods of prospecting that have been presented to the Institute since early in the year 1932. Most of these papers deal with the electrical method and most bear on problems of prospecting in the mining rather than the petroleum industry. There are 16 papers devoted to electrical methods, including five by C. and M. Schlumberger and E. G. Leonardon, five papers on magnetic methods, five on seismic methods and two general papers.

GUIDE TO ITALIAN PETROLEUM LEGISLATION (LA GUIDA ITALIANA DEL PETROLIO), compiled by the Revista Italiano del Petrolio: Rome (1934), 6¾" x 4¾", XL+643+XLIII pp.

This handbook contains the official text of all Italian legislation now in force governing the production and trade in petroleum, classified in seven parts, each further subdivided into chapters. Part I deals generally with the importation, elaboration, storage and distribution of mineral oils. Part II relates to the search for and development of petroleum deposits by the state and by individuals in Italy, Albania and the Colonies and the organization of instruction in petroleum engineering. Part III gives the constitution of l'Azienda Generale Italiana Petroli. Part IV regulates the composition and use of alcohol carburants and special fuels. Part V relates to customs, duties and taxes. Part VI gives a list of bureaus and authorities having to do with petroleum affairs, and Part VII relates to the place of the petroleum industry in the Italian Corporative State.

The volume should be useful and informative to all having or contemplating oil business in or with Italy.

STRUGGLE FOR WORLD POWER IN OIL (DER KAMPF UM DIE WELLMACHT OEL), by Anton Zischka; published 1934 by Wilhelm Goldmann, Leipzig. M 5.50.

The author traveled five times around the world and spent 10 years seeking clarity on the oil problem. He interviewed the oil magnates of Wall Street, talked with oil prospectors in New Guinea, bunked on oil tankers, listened to the uproar of an oil boom in California and an oil war in the Gran Chaco, digested mountains of statistics and dug deep into oil history. After all this he was in a position to write the "scenario of one of the world's most stirring dramas." And it is a lurid drama of titanic struggle, intrigue and war. Here is a conflict that is by no means finished, a problem that is still beset with many dark and dangerous angles threatening the peace of the world. The book will soon be available in English and French versions.

PETROLEUM PRODUCTION ENGINEERING: OIL FIELD DEVELOPMENT. By Lester Charles Uren, professor of Petroleum Engineering, University of California; published 1934 by McGraw-Hill Book Co., New York; 531 pages, 258 figures.

This is called the second edition of the author's Petroleum Production Engineering, published ten years ago as a single volume, but is really the first part of a two-volume work which the author now finds necessary for presenting the subject with all the detail required by students of petroleum engineering. The second part is to appear later as "Petroleum Production Methods."

The present volume, "Oil Field Development," covers operations from exploration for petroleum all through the acquisition of title to oil lands, planning the development program, drilling equipment and drilling methods, casing and methods of handling, fishing tools and methods, oil-field hydrology and exclusion of water from wells, finishing the well, and the keeping and meaning of well records. Every one of these broad subjects is discussed from all standpoints with a wealth of practical exemplification that discloses the author's intimate familiarity with the many angles of oil field development. The book is admirably designed as a comprehensive text book for petroleum engineering students, and is one that field engineers may well keep handy. If the companion book on production methods measures up to this one, its appearance is something to be looked forward to.

World Oil Production—Official Figures for 1934 Revised

All figures furnished direct to WORLD PETROLEUM by Governments, except where otherwise specified

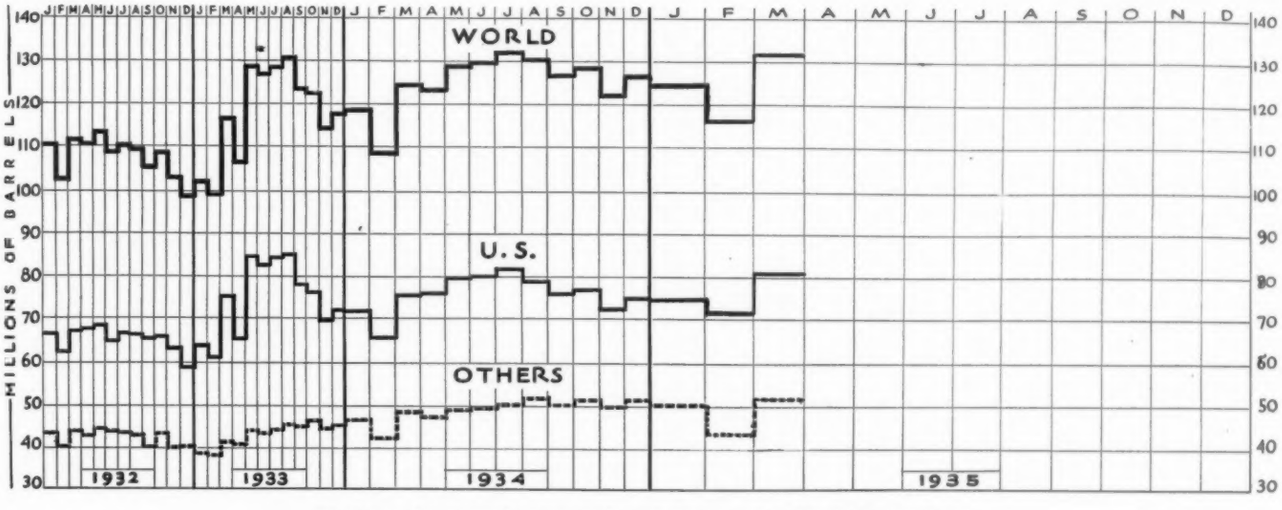
(Figures in U. S. Barrels—Conversion ratio 7 bbl.=1 ton)

Country	April 1934	May 1934	June 1934	July 1934	August 1934	September 1934	October 1934	November 1934	December 1934	January 1935	February 1935	March 1935
United States	75,796,000	79,870,000	80,040,000	81,548,000	79,058,000	75,810,000	76,776,000	72,463,000	74,772,000	78,715,000	72,763,000	80,116,000[1]
Russia	14,081,900	14,315,000	13,966,400	14,297,500	14,287,700	13,924,400	14,260,000	14,388,500	14,638,400	13,358,100	12,704,300	14,139,300
Venezuela	11,185,076	11,768,799	12,500,307	12,193,307	12,505,304	12,381,159	12,591,390	12,274,794	12,420,296	12,818,414	11,287,605	11,626,755
Roumania	4,981,000	5,008,000	5,178,000	5,223,000	5,556,000	5,335,000	5,467,000	5,324,000	5,522,000	5,355,000	4,860,000	5,256,000
Iran[2]	4,284,231	4,648,105	4,401,223	4,577,251	4,886,462	4,955,419	4,499,530	3,725,178	4,049,556	4,410,714	4,109,665	4,879,000
Mexico	3,206,490	2,714,828	2,918,793	3,303,055	3,434,516	3,276,612	3,393,770	3,332,926	3,425,314	2,894,167	2,661,632	3,519,148
Netherland India	3,489,024	3,609,816	3,577,056	3,678,745	3,456,215	3,410,785	3,577,399	3,553,067	3,743,810	3,716,300	2,630,642	3,640,266
Colombia[3]	1,193,736	1,730,095	1,683,691	1,646,739	1,691,314	1,627,632	1,646,293	1,633,654	1,554,172	1,653,647	1,141,696	1,466,821
Argentina	1,128,922	1,029,074	1,096,855	1,077,502	1,210,273	1,258,812	1,271,186	1,283,811	1,173,998	1,114,235	1,002,000[1]	1,237,000[1]
Peru[4]	1,037,127	1,085,192	1,187,030	1,233,804	1,300,253	1,259,901	1,303,554	1,169,826	1,250,247	1,248,465	1,105,508	1,218,852
Trinidad	876,950	926,785	947,122	1,008,669	975,697	919,469	906,152	907,655	930,877	915,220	843,619	919,848
British India	759,977	796,208	749,294	785,751	762,959	752,451	700,000[1]	700,000[1]	700,000[1]	700,000[1]	700,000[1]	700,000[1]
Poland	304,500	305,592	304,437	315,861	320,145	311,003	315,000	308,000	308,000	307,000[1]	297,000[1]	309,000[1]
Sarawak	166,999	166,565	158,669	164,206	161,504	155,400	156,800	152,600	158,200	183,300	136,500	152,250
Japan	118,770	126,170	125,202	131,397	129,326	124,870	125,229	119,970	131,059	171,441	151,797	164,050
Egypt	117,236	130,851	132,097	135,156	131,061	124,502	123,235	116,326	115,731	112,147	107,000[1]	113,000[1]
Ecuador	135,226	142,869	158,826	141,474	140,944	136,033	141,079	133,490	140,000	147,315	139,555	151,366
Canada	118,890	117,693	109,021	120,772	114,778	114,242	122,056	113,228	117,113	124,654	111,545	118,000[1]
Germany[5]	176,071	159,103	179,480	208,145	219,961	198,366	227,605	219,485	228,767	287,518	223,153	235,000[1]
Iraq[6]	100,000	100,000	100,000	100,000	100,000	100,000	100,000	357,000	1,054,599	425,000	1,631,000	575,000
France[1]	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000
Others[1]	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Total	123,379,125	128,871,745	129,634,503	132,011,334	130,563,412	126,297,056	127,824,278	122,397,510	126,555,139	128,778,637	118,727,612	130,657,656

[1] Estimate. [2] Anglo-Persian Oil Co. figures revised; fuel oil returned to the ground has been deducted. [3] Thuringia estimated 7,000 bbl.; official figure for Prussia. Russian Sakhalin included with Russia. Japanese Sakhalin included with Japan. [4] International Petroleum Company's figures. [5] Iraq production estimated to November 1934; represented by oil shipments through Tripoli and Haifa starting in November.

Official Crude Oil Production Figures for 1932 to 1935

	Total 1935 (Jan. thru Mar.)	Daily Average 1935	Total 1934	Daily Average 1934	Total 1933	Daily Average 1933	Total 1932	Daily Average 1932
United States	231,594,000	2,573,266	909,107,000	2,490,704	898,874,000	2,462,670	785,159,000	2,145,243
Russia	40,201,700	446,685	168,648,700	462,051	149,901,900	407,950	149,719,000	409,070
Venezuela	37,641,914	418,243	142,072,329	389,239	120,882,802	331,186	119,596,512	326,766
Roumania	15,471,000	171,900	62,006,000	169,879	50,971,200	139,647	50,491,205	137,954
Iran	13,398,000	148,882	52,663,782	144,284	49,581,280	135,840	45,122,435	123,285
Mexico	9,074,947	100,833	38,167,022	104,567	33,904,882	92,890	32,802,285	89,624
Netherland India	9,987,208	110,967	42,289,408	115,861	38,512,663	105,516	39,584,027	108,153
Colombia	4,262,164	47,357	17,340,724	47,509	13,157,127	36,047	16,384,956	44,768
Argentina	3,353,235	37,258	14,115,360	38,672	13,759,565	38,232	13,166,900	35,975
Peru	3,572,825	39,698	14,143,959	38,751	13,923,281—	38,146	9,899,266	26,026
Trinidad	2,678,687	29,763	10,894,363	29,847	9,560,039	26,192	10,023,780	27,387
British India	2,100,000	23,333	8,997,399	24,650	8,721,665+	23,893	8,600,312	23,500
Poland	913,000	10,144	3,697,617	10,130	3,858,085—	10,570	3,905,230	10,670
Sarawak	472,050	5,245	1,948,044	5,337	2,289,472—	6,273	2,274,043	6,213
Japan	487,288	5,414	1,484,962	4,068	1,377,761	3,827	1,575,333	4,375
Egypt	332,147	3,690	1,479,037	4,052	1,591,495	4,360	1,742,370	4,760
Ecuador	438,236	4,869	1,655,062	4,534	1,622,624—	4,446	1,573,857	4,300
Canada	354,199	3,935	1,418,810	3,887	1,147,825—	3,144	1,054,373	2,880
Germany	745,671	8,285	2,266,964	6,211	1,712,823	4,692	1,824,019	4,983
Iraq	71,921,404	799,126	2,411,599	6,607	1,200,000	3,288	1,200,000	3,300
France	138,000	1,533	552,000	1,512	552,000	1,515	552,000	1,508
Others	225,000	2,500	861,000	2,359	432,000	1,184	432,000	1,180
	449,362,675	4,992,918	1,498,221,141	4,104,715	1,417,534,489	3,884,022	1,296,712,823	3,544,940



World crude oil production in barrels by months, 1932–1935: Ratio of United States crude production to production in all other countries

Foreign Oil Legion

E. S. DULIN, president and Frank Champion, sales manager of the Byron Jackson Company, Los Angeles, Calif., sailed for England on the SS HAMBURG April 17. They contemplate spending a month between Great Britain and The Hague. Mrs. E. S. Dulin is accompanying Mr. Dulin.

O. B. ROGER, secretary and treasurer of the Shell Oil Co. at Toronto, who has been vacationing in London and on the Continent since mid-March, returned to Canada in the second week of April.

LEYLAND V. STANFORD, vice-president of the Sinclair Oil Co. arrived in Europe on the MANHATTAN April 2nd.

CAPTAIN J. F. LUCEY, president of the Lucey Petroleum Corporation, and formerly of the Lucey Export Corporation, has been spending his vacation in Europe. While in London he gave an impromptu talk at the Oil Industries Club Luncheon. Captain Lucey returned to the United States early in April.

H. M. E. Schurmann, chief geologist, Royal Dutch-Shell Group.

ORVILLE HARDEN, member of the Board of Directors of the Standard Oil Company (N. J.), who has spent all of his business career with the company, was elected vice-president early in April. The other two vice-presidents of the Standard Oil Company (N. J.) are: Christy Payne, Treasurer, and E. J. Sadler.

Mr. Harden was born in Chicago in 1894, and went to work in the manufacturing department of the Standard Oil Company when he was sixteen years of age. He became secretary to the Manufacturing Committee, and later was engaged in co-ordination work. In 1929 he was made a director. He is unmarried.

CAPTAIN L. R. ROGERS, marine superintendent at Abadan of the Anglo-Persian Oil Company, Ltd., has retired and returned to England. Captain Rogers had his first nautical experience as a cadet on the training ship, H. M. S. WORCESTER, and after leaving her spent the next four years on the old sailers. Following that he signed on with the British India Steam Navigation Company, later joining the Indian Government's cable-layer, PATRICK STEWART. He entered the service of the British Tanker Company in 1917 on whose vessels he sailed until late in 1920 when he saw his first shore duty as assistant marine superintendent. In 1925 he became marine superintendent and has held that position up to the present time.

DR. H. W. TWENHOFEL, University of Wisconsin, was elected president of the Society of Economic Paleontologists and Mineralogists at the meeting of the A.A.P.G. in Wichita, Kansas, in March.

DR. R. B. WEATHERBY, Geophysical Research Corporation, Tulsa, Oklahoma, was elected president of the Society of Petroleum Geophysicists at the same meeting.

VACUUM OIL COMPANY, LTD., gave a luncheon on April 3 in London to a representative gathering of automobile manufacturers and the lay and technical press, at which Mr. Wilson Cross, chairman, announced the adoption of the Clearsol Process and O. T. Jones, chief engineer, gave a brief semi-technical discussion of the process and its results.

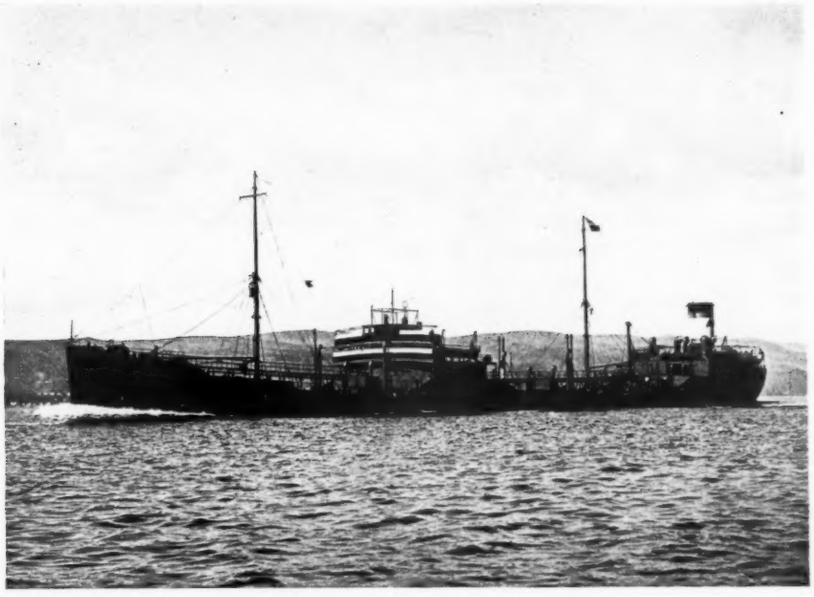
A. I. LEVORSEN, Chief Geologist of the Tide Water Oil Company, Houston, Texas, has been elected President of the American Association of Petroleum Geologists. Mr. Levorsen was formerly chief geologist of the Independent Oil Company, Tulsa, and upon merger of that company with the Phillips Petroleum Company he engaged in consulting work in the course of which he was responsible for the discovery of the Fitts pool in Oklahoma, a major oil discovery of 1934.

C. B. Nolte

C. B. NOLTE was elected president of Crane Co. on March 26. Mr. J. B. Berryman, who had been president since 1931, and who has been connected with the Crane organization since 1892, became Chairman of the Board. As chairman, he will be able to transfer his heavy responsibilities to Mr. Nolte's shoulders, and at the same time, will be in position to follow closely the further progress of the company.

Since 1909—just after Mr. Nolte received his Bachelor of Science degree in Mechanical Engineering at the University of Illinois—he has been with the Robert W. Hunt Company, Consulting, Testing, and Inspecting Engineers. Successively he became division manager, manager, vice-president and general manager, until in 1930, he was appointed president and general manager. This position he held until he was elected to his new office.

His thorough engineering background is attested to by his membership in the American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, American Railway Engineering Association, Western Society of Engineers, and Pacific Railway Club.



MV. San Arcadu built by Harland & Wolff, Ltd., for the Eagle Oil & Shipping Company, on her trial run.

SHIPPING

CONSIDERED by many people in the nature of a prophecy for future building policies, the announcement by Lord Stonehaven, President of the Institution of Naval Architects, at the recent annual meeting of that body in London, is important. The comparatively small number of tankers which had been built, he said, was to be regretted, but in view of the short life of those ships and the increased demand for oil which would result from the slowly dawning improvement of world trade, it had been calculated that some 750,000 tons of tanker tonnage would be required to be built each year during the next five years. Should this prove correct then shipyards will once again have reason to be grateful to the oil industry. At the present moment there is a slight lull in tanker construction although this is to a certain extent comparative after the concentration of interest which has been made on the recent construction which the Anglo-Saxon Company has placed. Shipyards are possibly tendering to a number of tanker owning companies, foremost among these being the Anglo-American Company which is asking bids not only from British but also from Continental shipyards. No orders have yet been placed and it is understood that the prices from British yards were somewhat on the high side.

The announcement that a new motor tanker of 14,500 tons has been ordered for Norwegian account recently induced Mr. Dagfinn Paust to protest in NORGES HANDELS OG SJOFARTSTIDENDE against this fresh extension of the tanker fleet. He pointed out that at present about 1,000,000 tons of tanker tonnage are already laid up and an appreciable number of the ships concerned consists of modern motor vessels. Moreover, about 1,000,000 tons of motor tankers are building at various yards, most of which are for the large oil companies, while of the remaining 250,000 tons practically the whole is for Norwegian owners. The demand for tanker tonnage, Mr. Paust said, remained fairly constant during the past year, but according to expert opinion shows no sign of a notable increase in the near future. In his opinion it is obvious that the mass contracting is delaying the time when supply and demand will become equal in a natural manner. The tanker pool was formed to enable shipowners to overcome the intermediate period, but will be wholly unable to attain this object if new contracting continues. The voices which are raised for the speedy dissolution of the pool are becoming louder with every new order that is placed. Mr. Paust added that many members of the tanker pool might like to enter into new contracts today but they abandon the idea out of loyalty to the great Norwegian joint interests in the pool. It was doubly distressing he said, that the fruits of the pool were being destroyed in this inconsiderate manner and that the existence of the pool was being jeopardised. It may mean lesser receipts by many millions of kronen for the country, based on the freight situation in the tanker market at present.

Considerable interest has also been aroused by the paper entitled "Ocean Transportation of Petroleum in Bulk" recently read before the North-East Coast Institution of Engineers and Shipbuilders by Mr. Robert F. Hand, Vice-President of the Standard Shipping Company of New York. This paper deals with some of the economic and operating problems associated with the ocean transportation of petroleum in bulk. Tanker rates are discussed in relation to the supply and demand of tanker tonnage and statistics of world tanker tonnage are furnished showing steam and motor tankers classified by ages and need for construction of new tonnage in the near future. Mr. Hand classifies petroleum products of marine transportation and the type and arrangement of cargo tanks, pumping and venting systems and safety equipment defined for vessels carrying various grades of products. He discusses improved crew accommodation and the welfare and comfort of the seagoing personnel and also the improved and safer method of tank cleaning and gas-freeing oil tankers by means of the Butterworth tank cleaning machines. He gives details of the factors entering into operating costs and suggests a new method of handling tanker depreciation. The merits of steam and Diesel engine propelled tankers in the various tanker trade routes are considered and attention directed to the difficulties of determining costs and freight rates, which is caused at this time by the foreign exchange situation. Mr. Hand also refers briefly to the development of Diesel engine tankers in the foreign service of the Standard Oil Company (N. J.) and the high-pressure, superheated steam turbine driven tankers in the American coastwise service of the Standard Shipping Company.

A. C. HARDY

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Italian Oil in 1934

ITALY produced from domestic sources during 1934 some 20,179 tons of crude according to official statistics just released. This supply was augmented by importation of 142,944 tons of crude; 388,104 tons of stock were treated in Italian refineries. Gasoline imports for the year amounted to 348,156 tons; fuel oil imports, 674,038 tons; gas oil imports 195,937, and lubricating oil imports, 65,678.

VENEZUELA

Shipments of Crude from Venezuelan Fields, January

	Barrels
Royal Dutch-Shell group	4,460,222
Lago Petroleum Corporation	3,699,505
Standard Oil Co. of Venezuela	2,051,620
Venezuela Gulf Oil Company	1,307,275
Arend Petroleum Company	219,579
Total	11,738,201

THE STANDARD of New Jersey interest (Lago and Creole Cos.) is now the largest producer of Venezuelan oil. Of the above shipments, more than 10,000,000 bbl. were destined for the Curacao and Aruba refineries, of the Royal Dutch and Standard Cos.

Shipments to the United States during the month were about 1,312,453 bbl., including 968,558 bbl. by the Venezuelan Gulf company and 343,895 bbl. by the Standard of Venezuela.

The Standard's field of Quiriquire, in the state of Monagas in eastern Venezuela, shows a constantly increasing production. Well No. 106 was completed in January, with an initial production of 1,620 bbl. daily. During the month the company had 64 wells in production, with an average daily output of 48,116 bbl. and an average per well of 752 bbl. The total production of the Qiriquire field to January 31, 1934 was 31,349,846 bbl.

The Cumarebo field of the Creole company had 32 wells in production during January, with an average output of 8,998 bbl. and an average per well of 299 bbl. Well No. 70 was completed during the month, with an initial production of 655 bbl. The total production of this field to January 31, 1935 was 11,147,881 bbl.

The Standard company's shipments from the Quiriquire field at Caripito during January amounted to 1,511,886 bbl., a record from this field. Work was approaching completion with the deep water loading line at Guiria, on the Paraguana peninsula.

Standard's Total January Production

	Barrels
Creole fields (Quiriquire and Cumarebo)	1,770,534
Lago Petroleum fields (Maracaibo basin)	4,182,232
Total	5,952,766

The Venezuelan Congress meets in annual session on the 19th of April and it is understood that the government will submit a new petroleum law, effecting certain modifications and amendments in the existing statute.

The Socony-Vacuum Oil Company was registered at Caracas late in 1934, with an authorized capital of 5,000,000 bolivars. The company has acquired certain parcels of land in the district of Maturín of the state of Monagas, in eastern Venezuela.

C. N. CLARK

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CANADA

DURING February this year the imports of crude petroleum into Canada amounted to 53,576,228 gallons valued at $1,568,818. This compared with 44,368,612 gallons for February 1934. The sources of origin were as follows:

United States	36,990,818 gallons
Peru	13,819,521 "
Venezuela	2,765,889 "

Gasoline imports amounted to 716,952 gallons for February 1935, valued at $64,683, almost doubling the import figures for February 1934.

Developments

TWO OIL firms, Mongeau and Robert Cie. Ltee., and the Pacific Oil Company, won permission in the middle of April to commence operations on the building of refineries and oil storage tanks in Pointe aux Trembles at the east end of Montreal. The projects represent a combined investment of $3,500,000. It was necessary to win the consent of the Metropolitan Commission before this project could be finally decided upon, and Mongeau and Robert Cie. Ltee. met with little or no trouble in the approval of their application. The Pacific Oil Company experienced more difficulty, but finally received permission also.

IN THE Turner Valley, Renfrew Royalties has resumed drilling operations and is making progress to the limestone objective. Ranchmen's well, on the Aldersyde structure, which is reported to have a gas flow of about 4,000,000 cubic feet daily and a small quantity of oil, is still being watched with interest. Drilling can only progress a few inches per day on account of the fact that the well is being drilled in such a closely packed sand.

Alberta's production of oil for the month of February amounted to 98,753 bbl., of which 96,014 bbl. came from the Turner Valley.

Company Reports

THE MCCOLL-FRONTENAC OIL COMPANY'S annual report for the fiscal year ended January 31, 1935 shows a slight contraction in gross earnings and net income. Earned surplus for 1934 amounted to $3,099,020 as compared with $2,888,301 for 1933. Investments and advances to subsidiaries were over $900,000 and loan and mortgages to customers, less reserve, amounted to $330,781. These three items were grouped together in the company's report for the previous year, when they amounted to $981,172.

In the annual report for the Imperial Oil Company, it is of note that the majority of the company's earnings came from sources other than the Canadian refining and marketing operations. Dividends from International Petroleum formed the majority of the earnings. The report comparing 1934 with 1933, is reproduced herewith.

Income and Surplus Account

(Years ended Dec. 31st)

	1934	1933
	$	$
Operating profit	4,218,735	4,692,715
Divs. from subsids.	19,012,941	
Interest on invest.	1,547,246	9,408,846
Prof. sale of secs.	992,731	
Profit	25,771,653	14,101,561
Less Dividends	24,881,256	13,415,169
Surplus for year	890,397	686,392
Prev. surplus	110,645,191	109,958,328
Less adjustments	13,856,885	
Bal. forward	97,678,703	110,645,191
Earnings per sh.	95.73	52.51
Paid	92.5	50.0
Working Capital		
Current assets	75,977,015	58,155,045
Current liabs.	6,921,796	8,911,731
Working capital	69,055,219	49,310,547
Ratio	11.0—1	7.24—1

R. C. ROWE

Oil Futures

The second month in the life of the petroleum futures market on the Commodity Exchange in New York finds interest steadily increasing accompanied by growing confidence on the part of the sponsors in the ultimate success of the undertaking. Naturally, the gasoline market was the most active, 182 contracts, 7,644,000 gallons, changing hands during the month. The crude oil market was more or less a nominal affair. Prices backed and filled in a narrow range during the month closing about firm and approximately unchanged. Considering the small range of price fluctuation, the volume of trading and the interest was very good.

The situation in the oil trade shows continued improvement in factors affecting future outlook. Present indications from Washington are that if any further legislation bearing on the oil industry is acted on at this session, the bills will be very considerably modified. Thus the Thomas bill, if passed at all, is likely to assume a much milder form. The same is true of the Wheeler-Rayburn utility holding company bill which is now being rewritten in Committee.

Production of hot oil has declined to a point where it no longer acts as a serious unsettling factor on the market being presently estimated in the neighborhood of 20,000 bbl. daily.

Federal production allowable and actual production have increased recently in an effort to keep stocks up to the economic level required by a gratifying increase in consumption of petroleum products, particularly motor fuel. Daily average production of crude oil for the first week in April amounted to 2,546,000 bbl. increasing to 2,615,000 bbl. by the second week in April.

In Texas the discovery near Anahuac by Humble made 650 bbl. per day in an area entirely controlled by Humble which has since made two new locations. A 6,000 bbl. well was completed in Fort Bend county by Trans State Oil Co. which attracted exaggerated attention in the daily press. Due to its location, surrounded by small pumping wells and with a north off-set only 85 ft. away producing but 104 bbl. daily, it is considered unlikely that No. 2 Ahlers will develop important new territory.

No. 1 O. Durbin discovery well in Crystal township, Michigan, is producing some 3,000 bbl. daily and is of major importance as proving for production a second trend in Central Michigan.

Motor fuel demand continued to increase both seasonally and in comparison to corresponding months of the preceding year. Most recent official government figures available—those for February—show demand amounting to 947,000 bbl. daily, 36,900 bbl. per day over the February 1934 demand. More recent indications confirm this trend as continuing through April and encourage the belief that it will continue in accelerated form during the summer. The expenditure of $4,800,000,000 for public works is bound to be reflected in an increased demand for motor fuel. Meanwhile increased sale and use of motor cars, greatly improved highways and growing acceptance of automobiles as a means for long journeys in summer, combine to assist gasoline demand.

While exports of motor fuel have fallen off very considerably this factor should be more than compensated for by growing internal demand. Motor fuel stocks have increased seasonally but not in excess of economic requirements.

Motor fuel prices continue firm having increased about ⅛ cent each week in April. Further increases in motor fuel prices as well as a 25 to 30 cent increase in the posted price of crude is anticipated for early summer. Retail price wars have largely disappeared except in a few isolated locations on the Atlantic seaboard.

Refinery gasoline quotations in the middle of April in Mid-Continent were 4½–4⅝ for 58–60 U.S.M. 62.9 and below octane being the same for export ex-Gulf.

Commodity brokers report a growing volume of inquiries from the oil trade, particularly from the marketing portion of the petroleum industry during the month. Apparently large individual consumers and jobbers of gasoline are investigating this new market in the hope that they may be able to make use of the hedging facilities which have proved such a stabilizing influence in other industries.

Accompanying this, many suggestions for changes and improvements in the existing set-up have come to light and have been taken up with the Petroleum Committee of the Exchange, which is working steadily toward their objective of perfecting the terms and conditions of the contracts now being traded. Naturally, evolving a satisfactory contract for a commodity like petroleum, out of which is manufactured so extensive and varied a line of products of widespread applicability, presents a complex problem which cannot be solved overnight. The Exchange realizes and admits that its contracts are not absolutely perfect to-day and will in all probability make some changes in the near future that will extend the useful field of the market.

Some of the suggestions are interesting. First, it is generally conceded that the inclusion of the one cent per gallon federal tax now included in the quoted price of gasoline is not necessary and can be dispensed with, because in the operation of a normal futures market the greater portion of the number of open contracts are closed before the option matures and only a small portion run to maturity and are delivered. This is one of the changes almost certain to be adopted.

In addition, of the three grades of tenderable gasoline, the base grade, on which quotations of price are based now, is the lowest quality of the three, 55 to 59 octane inclusive. A premium of one-quarter cent is paid to the seller for delivery of 60–64 octane inclusive and one-half cent for the delivery of 65 octane and above. The suggestion has come from many quarters to change this part of the contract so that the base grade traded in will be the 60–64 octane range with one quarter cent premium for delivery of 65 and above and one quarter cent penalty for delivery of 55–59 octane rating.

If both of the above suggestions are carried out, the market price of the nearest future month would be directly comparable with the spot price in the vicinity of the delivery points, and make for a more intelligible comparison.

The location of delivery points and licensed warehouses has also stirred up some controversy. Some observers feel a large number are essential, others feel only one, preferably at Houston, is sufficient. This feature of the whole problem is one which bears a good deal of thought and care. At the present time the Exchange officials feel that since the market is still small and the vast majority of contracts will be closed out before maturity, the conclusion is justified that the two delivery points now approved, New York and Houston, are sufficient for the time being. As the market grows other points can be added if necessary.

It was anticipated from the beginning that the growth and development of the crude oil futures market would be a slower process. For over eighteen months the price of crude has remained practically stationary and hence the desire for hedge protection is not present. Neither is there any inducement for the speculator to come in. However, when a change in the price structure of crude does take place, this market may receive a temporary stimulus.

Of the relatively large number of inquiries received from the trade by commodity brokers, the greatest number are from large consumers, marketers and jobbers of gasoline. A smaller number have come from independent refineries and producers. This is natural, considering that the market is located in New York and that the peak consumption season for gasoline is approaching. Also the fact that a higher price for gasoline this summer is generally anticipated has brought increasing numbers of inquiries from large consumers desiring price protection.

Gasoline Trading April 1 to April 31

Month	High	Low	Last
June	5.97	5.80	5.90
July	6.09	5.90	5.92
September	6.19	6.10	6.05
December	6.30	5.81	6.27

Volume gasoline 190 contracts: crude oil zero

The 1935 Henley

HENLEY'S 20TH CENTURY BOOK OF FORMULAS, PROCESSES AND TRADE SECRETS FOR THE LABORATORY, WORKSHOP, FACTORY, HOME AND FARM. New 1935 Revised Edition. Edited by Prof. T. O'Conor Sloane. 809 Octavo (6 x 9) pages. The Norman W. Henley Publishing Company, 2 West 45th Street, New York. $4.00.

For many years "Henley's 20th Century Book of Formulas, Processes and Trade Secrets" has been a standard work, which is kept modern by frequent revisions. The edition for the current year has been prepared under the editorship of Prof. T. O'Conor Sloane.

The scope of the book is so extensive that both amateur experimenters and professional workers should find it invaluable. There are approximately 10,000 different formulas.

The book has several features that distinguish it from the usual recipe book which limits itself to giving a formula, with which the user is left to shift as best he may. In the first place all technical terms used are carefully defined, so that the untrained operator can inform himself regarding the materials he is called on to handle. Especially noteworthy is the extensive glossary of chemical substances. A good outline of laboratory methods and operations necessary in the compounding of formulas is another evidence of the care with which the editors strive to guard the technically untrained user against mishaps and waste of effort.

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U. S. S. R.

Official Figures for Soviet Oil Operations

1935	Crude Production (bbl.)	Daily Average (bbl.)	Run to Stills (bbl.)	Drilling (feet)
January	13,358,000	430,935	11,400,000	248,672
February	12,704,300	453,725	10,909,500	334,544
March	14,139,300	456,107	11,714,500	449,417
Total First Quarter 1935	40,701,600	446,684	34,024,000	1,032,633
Total First Quarter 1934	40,488,000	449,866	34,558,000	998,616
Total 1934	168,648,700	458,042	145,141,000	4,122,898
Quota 1934	214,900,000	588,876	161,000,000	4,950,000
Quota 1935	232,400,000*	636,700	171,500,000	5,214,000

* Including gas; crude except gas = 198,800,000 bbl.
Crude conversion: seven bbl. = one ton.

Crude Production

DURING the First Quarter of 1935 Soviet crude production remained behind the quota for the period and is lagging behind the corresponding figure for the same period of last year. A general slowing down of operations has taken place not only in oil but also in coal and peat production.

During March crude production improved to above 456,000 bbl. per day against 453,000 bbl. per day in February and at the beginning of March.

Baku Operations

THE Controlling Organ of the Azerbaidzan Regional Communist Party, in its constant watch over the operations of the Baku oil industry has issued a grave warning to the oil operators of Baku that there is no objective justification for the arrears. The subsoil resources are intact, the supply of equipment to the oil fields has been materially improved and the personnel has been augmented. Only the victory of last year's plan fulfillment has relaxed the zeal of the operators and the tempo of activities and hence the drop in drilling and consequently in production. Drilling is down not only in quantity but in quality as well and the number of wells expected to come under production is below expectation owing to frequent breakdowns. Of 131 wells expected to be ready for operation during January and February only 84 were completed and 150 breakdowns have occurred at new wells. Compressor production, the most reliable source of operations, is down to 89 percent of plan.

Peterson, head of Azneft, Beria, Secretary of the Azerbaidzan Communist Party and Yefuni, Vice Chairman of Glavneft, have issued a joint statement to the effect that lack of organization is the main shortcoming of the Baku oil fields. The January storms at Baku have left considerable marks over the oil fields which have not yet been removed and frequent breakdowns are helping to delay progress. Mr. Yeffuni believes that the Baku oil field authorities are helpless and are unable to organize united action to liquidate the arrears. Mr. Beria has compared Baku to the Biblical Babylonian Tower and the confusion of languages. Baku authorities do not maintain any contact with their drilling teams and as a matter of fact they do not even know how to rate the drillers' ability.

Plan Fulfillment Soviet Industries First Quarter 1935

Industry	Percent
Oil	86
Coal	96
Pig iron	98
Steel	100
Production Motorcars	107
Production Tractors	107
Production Locomotives	108

Daily Output of Major Soviet Oil Fields

	Plan (bbl.)	Actual Production (bbl.)	Plan Fulfillment (percent)
Baku oil fields	405,000	363,600	89.0
Grozni oil fields	70,000	50,500	74.0
Maikop	23,800	18,900	80.0
All other	38,000	22,000	81.0
Total	535,800	455,000	86.0

Utilization of Gas in Baku

GAS utilization at Baku rose from 26,000 tons in 1924 to about 1,000,000 tons in 1934. The Baku electrical power plants cover about 72 percent of their fuel consumption with gas and gas covers about 94 percent of the fuel requirements of the oil fields. Gas is gradually being introduced for industrial purposes in Baku. But with all this the total utilization of gas as a source for fuel is still very low. Baku refineries could consume about 1,500 tons of gas (equivalent in fuel), but they use only about 600 tons per day. The low rate of utilization of gas is due to the fact that the pressure maintained in the gas lines is not constant and then the gas is contaminated with oil, sand and water and the hazard of breakdowns is very high. Plans were made to utilize gas as fuel as follows: 1,700,000 tons by 1935 and 3,300,000 tons by 1937. The replacement of fuel oil by gas would save Baku at least 45,000 tons of kerosene and 75,000 tons of fuel oil. Baku production of natural gas gasoline is very low. The total absorption of gas gasoline amounted to 37,000 tons in 1933 and 67,000 tons in 1934, while the

potentialities in 1934 were in excess of 86,000 tons of compressor gasoline, 52,000 tons of casing head gasoline, 7,000 tons of pumping gases and 9,000 tons of excess gases from gas-lift.

Steps were taken recently to readjust air-lift for gas in order to utilize the gases for absorption. Azneft is also building at present several carbon black plants and while Baku could meet over 50 percent of the Soviet requirements in carbon black the gas resources are wasted and blown into the air.

U. S. S. R. Oil Exports by Products 1934

(Tons)

	1934	1933	Percent Change
Crude Oil	458,519	525,518	−12.7
Petrol	1,119,938	1,295,966	−13.6
Kerosene	435,573	570,328	−23.6
Luboils	248,352	239,990	+35.5
Bright Stock	31,119	12,593	+147.1
Mazout & Diesel	1,385,902	1,633,628	−15.2
Gas Oil & Solar	591,385	615,724	− 4.0
Asphalt	28,903	29,459	− 1.9
Paraffin Wax	14,138	5,532	+155.6
Others	1,357	705	+92.5
Total	4,315,186	4,929,443	−12.5

U. S. S. R. Oil Exports by Countries of Destination 1934

(Tons)

	1934	1933	Percent Change
Belgium	148,144	259,652	−42.9
British Empire	452,793	488,823	*
Germany	458,630	505,500	− 9.3
Holland	26,993	61,132	−55.8
Denmark	158,348	122,533	+29.2
Spain	493,546	342,158	+44.2
Italy	622,099	998,682	−37.7
China	53,329	106,750	−51.0
Lithuania	18,577	16,938	+ 9.7
Norway	20,950	60,799	−65.5
Persia	37,253	32,886	+13.3
South America	52,791	72,436	*
Turkey	24,815	56,099	−55.8
Finland	23,232	20,299	+14.8
France	730,491	719,230	+ 1.6
Sweden	153,234	218,618	−29.9
Japan	266,919	366,442	−27.2
Others	564,227	471,493	+19.0
Total	4,315,186	4,929,443	−12.5

* Figures not comparable.

Grozni

No IMPROVEMENTS are reported from Grozni. Drilling and production are below plan and also below the corresponding figures of last year. The present output has improved to slightly above 50,000 bbl. per day. Reports from Grozni show that the latest shortcoming of the fields is a mania for conferences and meeting of all kinds for a so-called exchange of opinions and views on drilling and production in which the same problems come up for discussion by the same participants.

Yesterday's conference on drilling and drilling speed held at the offices of the field Superintendent will be repeated today all over again at the offices of the Secretary of the regional Committee of the Communist Party and the same subject will come up for discussion tomorrow at the offices of K. Riabovol, head of Grozneft and a day later at a meeting of the Engineering Institute and at all these conferences and meetings at the various places the same engineers and experts will have to appear and to be present. The engineers of Grozni are thus being compelled, either to take part in the discussions or to listen attentively to speeches made by others, day after day. They have little time left for actual routine work. The reports further state that conditions are entirely different at Baku. Baku engineers do not waste time in conferences but spend most of their time in offices doing some clerical work, which is likewise of no use and thus both major oil trusts Baku and Grozni are in arrears owing to mismanagement and to lack of organized action.

Emba

THE CASPIORSK pipe line between Guryeff on the Caspian sea and Orsk has been under construction since 1931. Between Guryeff, the seat of Emba and Orsk which is to have a refinery, the distance is about 700 kilometers. The Caspiorsk project has been designed to create a natural outlet for crude from Emba oil fields, which, lacking roads and transport facilities, have been hindered in progress during the past. The natural outlet for Emba crude is Magnitogorsk, an industrial center about 225 kilometers from Orsk, Cheliabinsk—an important grain center about 300 kilometers from Orsk, Khalilovsk—the metallurgical combinate and Orsk proper which is rich in gold mining and has a huge locomotive plant. Uncertainty of crude production at Emba of recent years (1934 production 1,680,000 bbl.) has led to a design for the Orsk refinery suitable for Baku crude (Balakhani oil field) but several factors have had to be taken in consideration and the Orsk building plans were delayed. In the meantime changes have taken place in Emba. The Koschagil and Iskine oil fields have become important producers and it looks as if the Caspiorsk project would now rely on Emba crude. This crude is of a light grade and lubeoil base and could be processed for gasoline, kerosene, and lubeoil, with some residues for cracking. The Orsk refinery will have a capacity of 3,000,000–3,500,000 bbl. of crude per annum and will yield about 110,000 tons of gasoline, 80,000 tons of kerosene and some 200,000–250,000 tons of light Diesel oil.

Maikop

AN ALL UNION SOVIET DRILLING CONFERENCE was held during the second half of March at Neftgorsk, which is the seat of Maikop oil fields. The Conference to clarify the position of drilling in all Soviet oil fields in 1935 was sponsored by Glavneft for all Soviet oil fields to participate namely Baku, Grozni, Maikop, Vostokneft, etc.

Mr. Poliakoff, chief engineer of Glavneft has reported on Soviet drilling problems in general. M. Galperin, Zubkoff and Pranitzin have reported on the supply of drilling equipment, utilization of the same and accidents in Soviet drilling, cave in of wells and so on. Mr. Poliakoff has emphasized the fact that while during the period between 1919 and 1935 about 900 oil fields were opened in U. S. A. and about 324,600 wells were drilled, the Soviets have opened for operation only 20 fields and only 8,243 wells were drilled during the same period. Mr. Poliakoff has further stated that while 1,980 and 2,970 feet are being drilled per rig per month in California and Oklahoma the corresponding figures for Soviet oil fields are 390 feet in 1933, 518 feet in 1934 and 780 feet planned for 1935.

Soviet Drilling

LOW QUALITY of drilling operations and slow tempo of drilling speed continue to be the main factors hindering progress and to date the drilling division remains the weakest link in the Soviet oil industry.

The average depth of drilling in Soviet oil fields varies between 3,500 and 4,000 ft., showing 3,000 to 3,300 ft. at Baku and 3,300 to 3,600 ft. at Grozni. The recently discovered Molgabek oil field of Grozni, which is expected to change the aspect of crude production of Grozni requires drilling to depths of 7,000 to 8,000 ft. The Podnadvig layers are likewise situated at a similar depth, although the first well from this sand produced from about 4,000 ft. The Maikop pay is situated at depths between 5,000 and 6,500 ft., but deep drilling in Soviet fields remains a novelty and lacking routine as well as adequate equipment it is likely to require some time before progress will be made. Today the losses of drilling time are high and only about 25 to 30 percent of the total time required for drilling is actually devoted to making hole.

Drilling Operations

(Figures in feet)

	1934	1933	Change percent
Production Drilling	3,100,000	1,875,000	+58.0
Prod.-Prospecting	759,000	495,000	+54.0
Prospecting	263,000	505,000	−45.0

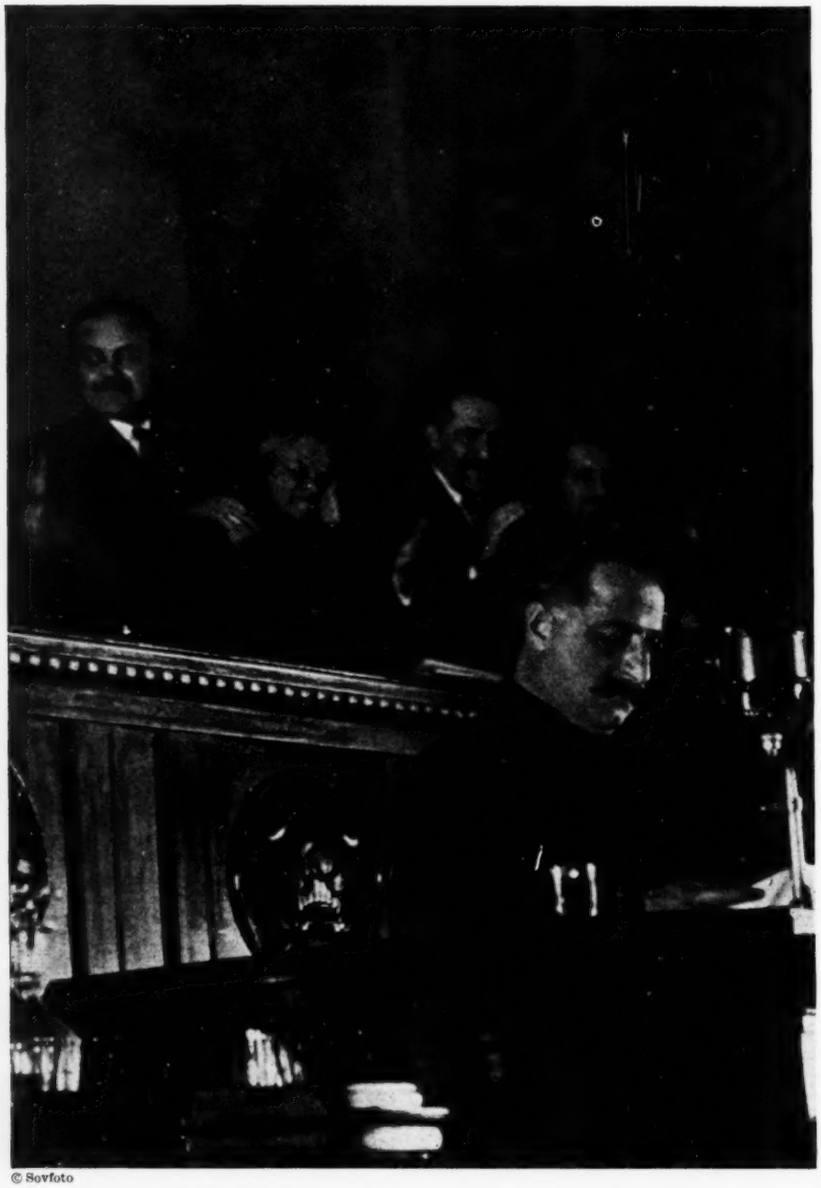
During 1934 eight deep wells were sunk at Emba. Two of these wells have reached 8,650 ft. which is the highest record of all time for Soviet drilling. The projected depth of these two wells is 10,000 ft. The other six wells are projected for 8,250 ft. The first deep well sunk at Emba several years ago has required almost two years to drill the first 2,000 ft. and it took 20 hours to lift the tools.

Two wells drilled at Kala (Asisbekoff field of Baku) have struck the Kirmakin layer at 7,600 ft. and 6,100 ft. respectively. Both wells are the deepest wells on record for Azerbaidzan.

Of a total of about 1,200 rotary outfits operated in Soviet fields only about 200 units are adjusted for deep drilling and there are not sufficient pumps available to have two pumps operating with each outfit.

Some 5,000,000 ft. of distance were scheduled for drilling in 1934. Compared with the 2,875,000 ft. drilled in 1933 the increase would have amounted to 78 percent.

Actual drilling in 1934 amounted to 4,122,000 ft. and the increase over 1933 is about 48 percent. Of the total increase the largest share is to be noted in production drilling, some improvement has also taken place in prospecting



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Stalin's bosom friend and fellow Georgian, Sergo Ordjonikidze, Commissar for Heavy Industry, who is not afraid to face the bitter realities of the Russian oil situation, characterizes this pride of Soviet industrial development as "filthy—barbaric—Asiatic!" while high officials of the XVII All-Union Soviet Congress applaud.

production drilling but prospecting proper has remained practically unchanged.

The actual figure for prospecting drilling in 1934 was 450,000 ft. against the 263,000 ft. indicated in the table. The difference between the actual and indicated figures apparently was included under the item Prod.-Prospecting drilling. However when the actual figure of prospecting drilling is compared with the plan (725,000 ft.) the arrears are rather high.

Up to 1933 the ratio in percent of prospecting to the total of all drilling amounted to 12–15 percent.

THE AVERAGE drilling speed in 1934 consisted of routine and special drilling.

So called shock brigading speed was attained at Kala of Baku, Molgabek of Grozni and Maikop where wells at depths between 3,600 and 4,000 ft. were drilled with speed of 1,300 ft. per drill per month or even more. The Mikoyan oil field of Baku shows an average of about 300 ft. per month. High losses of drilling time and unproductive stoppages of drilling owing to lack of minor necessities and numerous breakdowns at wells which could have been avoided are still a common occurrence at all Soviet oil fields.

A total of 6,972 rotary drilling months were operated by all Soviet oil fields in 1932, the figures for 1933 are 7,175 months and 1934 judged by figures available for the first six months are 8,000. Of these totals the major fields Baku, Grozni and Maikop show the largest share, namely 5,300 in 1932, 5,500 in 1933 and about 6,500 in 1934. However the major oil fields show also high losses of drilling time running into 35 to 40 percent. The oil fields outside the Caucasus show similar results of drilling. Better organization and efficiency which are entirely possible in all Soviet oil fields would undoubtedly cut the losses to one half of the indications and this would improve the speed at least 20 to 25 percent.

Stoppages of drilling and breakdowns govern all Soviet drilling and particularly prospecting which is due to lack of experience and to lack of supplies. Individual improvements were noticed in the major oil fields, but the effect is offset by lack of ability to utilize the proper drilling time for useful operation. Average life of the bit is short not exceeding 35–40 ft. of drilling as against 200 ft. of drilling in the United States. The Soviet drillers prefer to use fish tail drilling bits rather than roller type bits. This aversion is possibly justified against roller bits of domestic make, which under the circumstances, are as yet not fit for heavy duty. There is no criticism, or at least there was no criticism of roller bits imported from the United States.

Equipment for drilling is poor. There is a large inventory of two speed drilling tackle which is largely worn out. The new supply consists of four speed sets and there are no spares and repair parts for the old sets, hence repair work is difficult. The lack of power pumps 7½ x 16 and 18 inches is appalling and no steam boilers are available for such fields where electricity is not to be had (Maikop, Vostokneft, etc.). The technical supply of the drilling division is a serious matter which the Soviets should not overlook. Soviet key men of the oil industry have often stated that good drilling does not depend only on good equipment but also on auxiliaries. The results of drilling depend on good roads, transport facilities, power and water supply and adequate repair shops almost as much as on equipment.

Soviet oil fields employ "fish tail" drilling bits in soft or tertiary formations of Baku and

Average Distance and Duration of Drilling Per Bit in Soviet Oil Fields

	1932		1933		1934	
	Average Distance of Drilling per Bit (feet)	Duration of Drilling per Bit (hours)	Average Distance of Drilling per Bit (feet)	Duration of Drilling per Bit (hours)	Average Distance of Drilling per Bit (feet)	Duration of Drilling per Bit (hours)
Baku	33	5	29	8	39	11
Grozni	16½	7	24	11	35	13
Vostokneft (Urals)	6	3	11	5	15½	6

Grozni. At hard or Paleozoic formations as in the Ural oil fields Reed and Hugh type drilling bits are used.

Lomoff on Drilling

G. LOMOFF, former head of Napthasyndicate and member of the Soviet fuel board, states that Soviet progress in the fuel industry is immense, but production of oil is in arrears. While the general increase of production of Soviet heavy industries in 1934 amounted to 27 percent over 1933, the oil industry increased only 12.8 percent and although between the VI and VII All-Union Soviet Congresses the oil industry increased production 30 percent, it lags behind all other branches of the Soviet heavy industry and particularly behind the output of tractors which are the principal consumers of oil. During 1934 the oil industry fulfilled its plan at the rate of 88.6 percent in production and 83.7 percent in drilling, and while Baku and Maikop oil fields were able to show 100 percent of plan fulfillment the Grozni and Emba fields showed arrears of the plan of 43.8 and 43.1 percent respectively. Neftdag oil field has shown arrears of 95 percent and not a single other Soviet oil field has fulfilled the plan for 1934 in drilling.

High arrears of plan fulfillment are indicated by the oil fields outside of the Caucasus and Com. J. Stalin is absolutely justified in his statement: "Lack of attention is responsible for the slow development of oil centers in the Urals, Bashkiria and Emba." Crude production of these fields in ratio percent of the total production of all Soviet oil fields during the second PIATILETKA was expected to increase from 2.5 to 12–13 percent, however the actual share of these fields during 1934 (Second year of the Piatiletka) amounted to 2.4 percent and the tendency does not show any increase in 1935. Slow drilling is responsible for retarded progress and this is particularly evident at Neftdag where the drilling speed per well per month does not exceed 168 ft. and of the 63,000 ft. of distance of drilling as planned for 1934 only 16,500 ft. were actually drilled. Neftdag oil field has been under the strain of lack of housing and consumers goods, consequently the turn over of labor is high. Of a total of 986 hands required for the field during the year, 1617 hands were hired and 1724 have left their jobs. The Middleasia region requires millions of barrels of oil which, owing to mismanagement at Neftdag and slow progress at Haudag, have to be hauled from Baku.

Operations at Emba are likewise unsatisfactory. Production in 1934 was below the corresponding figures for 1932 and the main shortcoming of Emba lies in lack of roads and transport facilities. The Emba oil fields require a pipeline and railroads. The Caspiorsk pipeline from Guryev to Orsk is being completed slowly and the arrears of Emba are in the meanwhile increasing.

Grozni operations have been on the decline since 1931 and the shortcomings of Grozni are due mainly to slow drilling and to inability to master the technique of deep drilling. Only about 25 percent of the time used in drilling at Grozni is spent in making hole and the results obtained are about one tenth of drilling results obtained in the United States.

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Barinov, soft-spoken proletarian, former worker in the oilfields of Baku, whose choice of experts did not save him from unsuccess at Azneft: but whose devotion to Marxian principles has made him a place as the political *head of the entire Soviet oil industry—Glavneft.*

The Soviet oil industry is making slow progress in the yield of light products from the crude potential. The actual increase has grown only 3.5 percent from the corresponding yields in 1931 and measured by weighted quantities the figures for 1934 are below 1931. The yield of light products from the crude potential in 1931 amounted to 33.5 percent and the corresponding figure for 1934 is 33.05 percent which is due to heavy crude grades predominating in production of Baku and ineffective utilization of the refining plants at disposal. The refineries are being operated in uncivilized ways. Each percent yield of light products from the crude under refining represents 1,421,000 bbl. of kerosene and gasoline and in addition Soviet wells are not hermetized and the losses in evaporation are high. Evaporation losses in the oil fields incurred during 1934 are estimated at about 3,500,000 bbl. of gasoline.

The building of cracking facilities is proceeding slowly. At Saratoff, Orsk, Grozni, Konstantinovka and at several other places long delays have taken place in bringing under stream the divisions of the cracking installations which were completed already.

J. WEGRIN

UNITED STATES

	Daily Crude Oil Production bbl.	Daily Runs to Stills bbl.	Total Motor Fuel Stocks bbl.	Imports for week bbl.	California Shipments East for week bbl.
Week ending March 30.....	2,589,500	2,430,000	66,613,000	680,000**	260,000
	473,500*				
Week ending April 6.....	2,546,000	2,360,000	66,211,000	1,153,000**	125,000
	464,000*				
Week ending April 13.....	2,615,000	2,505,000	66,408,000	931,000**	279,000
	468,500*				
Week ending April 20.....	2,621,500	2,535,000	66,311,000	948,000**	157,000
	467,500*				

Underlined figures indicate improvement in statistical position—decrease in production, runs to stills, gasoline stocks and imports.

* Estimated total production of the Rusk-Gregg field, East Texas, official and unreported.

** Import figures include all oil imported, for domestic use and in Bond for re-export, it being impossible to make the separation in weekly statistics.

Federal Legislation in the Making

FOUR major federal legislative measures affecting the oil industry now before the Congress are due for immediate action and are at this time being debated.

The Thomas oil control bill, which provides for federal allocation of production between the states, for approval of interstate compacts and for federal intervention in the case the allocation quotas are not complied with, met many objections from within the industry and from state officials who claimed the Connally bill, discussed in the preceding issue of WORLD PETROLEUM, was entirely sufficient and that the new bill would in effect be the "entering wedge of regimentation and monopoly," as expressed by Governor James V. Allred of Texas. It is rather doubtful that the new Thomas bill is necessary at all; since the Connally bill protects the interstate commerce from "hot" oil shipments, whole states themselves are gradually and effectively controlling production of oil above their quotas, recent "hot" oil production in East Texas field dropping to but 20,000 bbl. per day, a volume which does not exercise much influence on the markets. Opinions among state executives and within the oil industry itself were considerably divided on the desirability of the Thomas bill. Proponents of the bill include Secretary of the Interior H. L. Ickes, Judge Amos L. Beatty of the Phillips Petroleum Company, Russell B. Brown representing the Independent Petroleum Association of America, Harold B. Fell, representing National Stripper Well Association and Governor A. M. Landon of Kansas. Opponents of the Thomas bill at this time are: Governor James V. Allred of Texas, Governors of Oklahoma and California, Axtell J. Byles, president of the American Petroleum Institute, E. O. Thompson, chairman of the Texas Railroad Commission and Texas State Attorney General William McCraw who questioned the constitutionality of the Thomas bill. The bill is due to be reported by the Senate Committee on Mines and Mining early in May probably carrying several amendments. The passage of the bill in its present form is very unlikely, though it will probably be passed eventually in a compromise form varying but little from the Connally oil bill, and not permitting federal government interference with allocations or their enforcement within the states.

The Wheeler-Rayburn utility holding company bill which originally provided for the elimination of all holding companies by 1940 and for immediate strict regulation and supervision of the natural gas industry is now being re-written in the Committee and is due to be shortly reported to the House of Representatives. The Wheeler-Rayburn bill is very generally opposed by utility companies and by investors in these companies and it is freely predicted that the bill will be passed as a strictly regulatory measure, rather than a confiscatory measure as originally drawn.

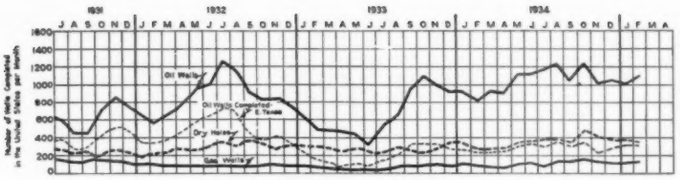
The Wagner labor bill now in the Senate Committee in fact prohibits all companies from promoting company unions, while not restricting organized labor from drafting all labor in all industries into the American Federation of Labor. The Wagner bill is definitely opposed by almost all large and small employers of labor as it will eventually entirely eliminate company unions. The passage of the Wagner bill is problematical in its original form, but it may be adopted after amendments which will considerably soften its primary intentions.

The continuation, after June 16, 1935, of the National Industrial Recovery Act is dependent upon its extension by Congress, and Congress is at this time debating the form in which the N.I.R.A. is to be extended. Major changes relieving small industrial concerns from burdensome over-regulation and oppression will probably be made in the new N.I.R.A., while clauses held unconstitutional by the courts will be either eliminated or corrected.

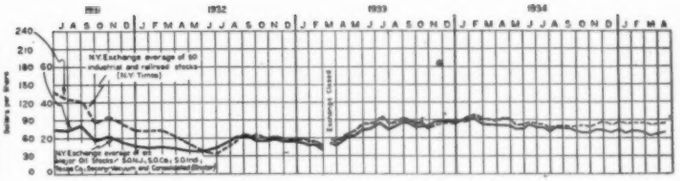
In the East Texas field considerable apprehension was caused by the appointment of R. W. Van Fleet as director and supervisor of

Gulf Export Prices for Major Oil Products

	Product	Cents per Gallon			
		March 22	March 29	April 5	April 14
Gasoline:	U. S. Motor	4⅜	4⅜	4⅝	4⅝
	64/66-375 E. P.	4¾	4⅞	5	5
	59 Oct. & below	4⅝	5	5	5
	65 Oct. & above	5	5¼	5¼	5¼
Aviation Gasoline:	73 Oct. & above	9	9	9	9
Kerosene:	44 w.w.	4¼	4¼	4¼	4¼
	41–43 w.w.	4	4	4	4
	41–43 p.w.	3⅞	3⅞	3⅞	3⅞
Gasoil:	26–30 transluse.	2⅞	2⅞	2⅞	2⅞
	30 plus transluse.	3	3	3	3⅛
Fuel Oil:	Bunker purposes (per bbl.)	$1.00	$1.00	$1.00	$1.00
Grade C:	Cargo lots (per bbl.)	$ .80	$ .80	$ .80	$ .80
	Diesel oil (per bbl.)	$1.70	$1.70	$1.70	$1.70
Lubricating Oil:	Bright Stock No. 8	23	22	22	21
(New York Export	Bright Stock No. 6½	22½	21½	21½	21½
Market)	Warren E.	19	19	19	18½
	600 Unfilt.	15	15	14½	14½
	650 Unfilt.	17	16	16	16
	600 Flash s.e.	17½	16½	16½	16½
	630 Flash s.r.	21	21	21	21
	Neutral 200 No. 3	35	33	33	28½
	Neutral 150 No. 3½	27	27	27	23½
So. Texas:	300 No. 3 pale	7	7	7	7
	500 3½ pale	7⅞	7⅞	7⅞	7⅞
	750 4 pale	9	9	9	9
	1200 4 pale	9½	9½	9½	9½
	500 No. 5–6 red	7⅞	7⅞	7⅞	7⅞
	750 5–6 red	9	9	9	9
	1200 5–6 red	9½	9½	9½	9½
Crude Oil:	East Texas crude delivered at Gulf port for Export	$1.17	$1.18	$1.19	$1.19



U. S. drilling; comparison of oil wells, dry holes, and gas wells.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N.Y. Exchange average of 50 industrial and railroad stocks (N.Y. Times)
Dollars per Share

Six major oil stocks in relation to 50 industrial stocks on the New York Stock Exchange.

federal investigators in the field by Secretary of Interior H. L. Ickes. The dissatisfaction was due to the complete lack of experience of R. W. Van Fleet in the oil business, since he formerly was an insurance agent in Winnetka, Illinois.

Prices Very Firm

REASONABLY effective control of "hot" oil production in the East Texas field and seasonal improvement in the motor fuel consumption with currently very favorable motoring weather resulted in a marked advance of refinery gasoline quotations and in service station prices. Refinery gasoline prices advanced up to ½ of a cent per gallon throughout Mid-Continent, East Texas quotations lagging but ⅛ of a cent behind Group 3 markets. Retail markets became further stabilized, more particularly in the West, but some recurring price cutting was noted on the Atlantic Coast markets. Natural gasolines advanced about ½ of a cent per gallon during the past month in seasonally slow trading.

The more recent important changes in retail markets included: an increase of 2 cents per gallon in tank wagon and service station prices by the Standard Oil Company of Kentucky in Atlanta between March 26 and April 5; an increase of 1 cent per gallon by same company over large sections of its marketing area on April 2; a reduction of 2 cents per gallon by the Standard Oil Company of California in Los Angeles on April 1; 0.3 cents per gallon advance by the Standard Oil Companies of Indiana and Nebraska throughout their territories; and 0.75 cents per gallon advance by The Standard Oil Company of Ohio throughout its territory.

Crude oil prices during the past month remained very strong and unchanged at $1.00 per barrel for 36 gravity Mid-Continent grade, and at $1.00 flat per barrel for the East Texas crude. Further advances in gasoline markets, carrying refinery gasoline, middle grade, to 5¾ or 6 cents per gallon in Group 3 market will probably result in a 25 cent per barrel advance in crude oil prices, which is in fact anticipated for early summer.

Tank-wagon service station motor fuel prices per gallon, regular grade, including all taxes, in representative districts in the middle of April were:—13.05/15.8 cents in metropolitan New York (13.0/16.5 cents in Newark, N. J.); 11.8/14.3 cents in Boston, Mass.; 11.5/13.0 cents in Providence, R. I.; 14.9/16.9 cents in Chicago; 16.25/18.25 cents in Ohio; 16.5/18.5 and 13.5/15.5 cents in San Francisco and Los Angeles respectively; 16.0/18.0 cents in Oklahoma; 14.0/16.0 cents in Dallas and Fort Worth, and 15.0/17.0 cents in Houston, Texas; 14.5/16.5 cents in St. Louis and East St. Louis; and 24.0/27.0 cents in Montreal, Canada; all with a 2-cent differential for premium grade.

Refinery gasoline quotations in the Mid-Continent district advanced up to ½ of a cent a gallon during the last month and further advances were anticipated. Refinery gasoline was quoted on April 20 in a very strong market at 4½–4⅝ cents per gallon for 58–60 U.S.M. grade 62.9 and below octane rating in Group 3, Oklahoma market; and 63.0–70.9 octane rating, U.S.M. grade was quoted at 5¼–5⅜ cents per gallon. The East Texas markets were quite strong, lagging but ⅛ of a cent behind Group 3 quotations. On the East Coast, at Bayonne, U.S.M. grade 60.0–64.9 octane rating gasoline was quoted at 5¾ cents per gallon (3.40 cents gold *). Gulf Coast prices for export on April 20 were firmer at 4½–4⅝ cents per gallon (2.71 cents gold *) for grade 58–60 U.S.M.

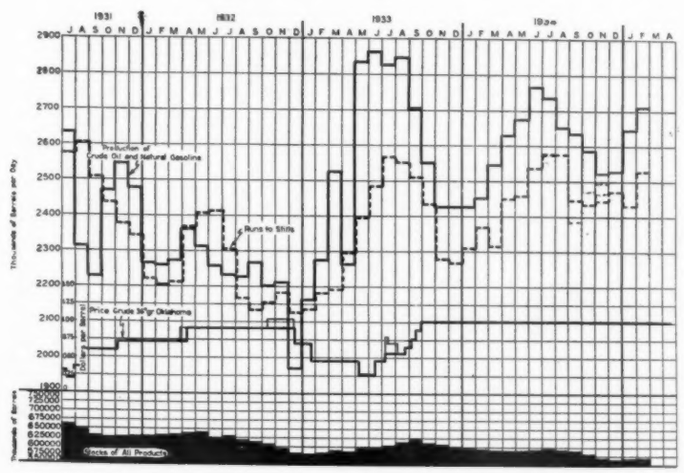
Natural gasolines were carried upwards together with refinery gasolines, though seasonally the trading was slow. On April 20 grade 26–70 was quoted at 2¾–3 cents per gallon (1.70 cents gold *) in Oklahoma; at 2½–2¾ cents per gallon (1.55 cents gold *) in North Texas; and at 3.00 cents per gallon (1.77 cents gold *) in North Louisiana.

Kerosene prices were very weak during the past 30 days; on April 20 grade 41–43 w.w. was quoted at 3½–3⅝ cents per gallon in Group 3, Oklahoma market; and at 5–5¼ cents per gallon (3.10 cents gold *) on the East Coast at Bayonne. Gulf Coast prices for export dropped around ½ of a cent per gallon in last month to 3⅞–4 cents per gallon (2.29 cents gold *) for 41–43 p.w. grade and 4–4¼ cents per gallon (2.43 cents gold *) for 41–43 w.w.

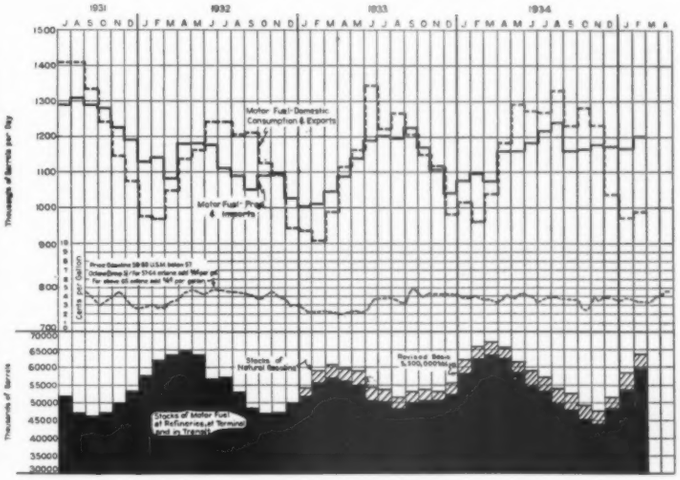
Further improvement in refinery gasoline quotations, gradual elimination of price wars and seasonal influences, together with favorable developments in the producing branch of the oil industry, should be reflected during early summer in higher quotations for motor fuel and crude oil.

* U. S. Dollar at 41 percent discount.

U. S. production, runs to stills and price of crude oil in relation to stocks of all petroleum products.



U. S. consumption and exports, production, imports and prices of motor fuel in relation to motor fuel stocks.



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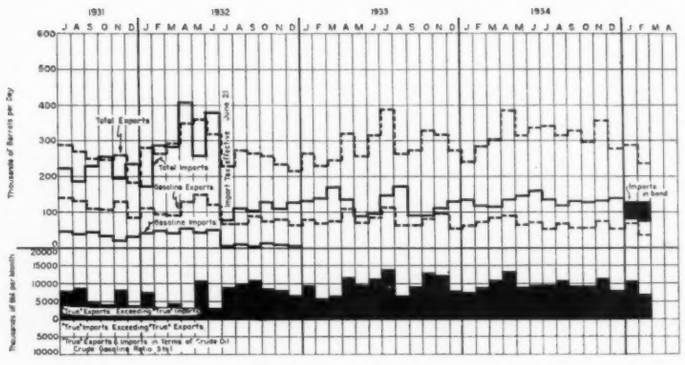
1931
1932
1933
1934
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Thousands of Barrels per Day
Total Exports
Total Imports
Gasoline Exports
Gasoline Imports
Import Tax Effective June 22
Imports in bond
Thousands of Bbl per Month
"True" Exports Exceeding "True" Imports
"True" Imports Exceeding "True" Exports
"True" Exports & Imports in Terms of Crude Oil
Crude Gasoline Ratio 3 to 1

Total U. S. imports and exports and gasoline imports and exports in relation to true exports exceeding true imports.

Exports Decline Again

DURING February, 1935, total gross imports of all petroleum products into the United States amounted to 3,689,000 bbl., 131,800 bbl. per day, as compared with 4,074,000 bbl., 131,700 bbl. per day, imported during the preceding month; out of this total during February, 1935, 2,104,000 bbl., 75,000 bbl. per day, were imported for domestic use and 1,585,000 bbl., 56,800 bbl. per day, were imported in transit either for refining and re-export or for use in vessels in foreign trade. During the preceding month, January, 1935, 2,563,000 bbl., 82,600 bbl. per day, were imported for domestic use, and 1,521,000 bbl., 49,100 bbl. per day, were imported in bond as indicated above. The crude oil imported for refining and re-export amounted in February, 1935, to 773,000 bbl. Therefore during January and February the net imports continued well within the federal allowable of 108,400 bbl. per day.

Exports of all petroleum products during February, 1935, declined very appreciably from the preceding months dropping to 6,560,000 bbl., 234,500 bbl. per day, as compared with 8,780,000 bbl., 283,000 bbl. per day, shipped during January, 1935, and 8,630,000 bbl., 278,000 bbl. per day, exported during December of 1934. The February, 1935, exports were also much lower than the exports in February of 1934 when 7,932,000 bbl., 283,000 bbl. per day, were shipped, a decline of 20.9 percent. Shipments of crude oil from United States during February, 1935, continued to be in reduced volume amounting to 2,804,000 bbl., 100,000 bbl. per day, as compared with 2,369,000 bbl. exported during the preceding month, and daily average crude oil exports of 112,800 bbl. during the whole of 1934. In February of 1935 crude oil exports constituted 42.7 percent of the total exports of all petroleum products.

Crude Production Seasonally Higher

CRUDE oil and natural gasoline production during March, 1935, averaged about 2,700,000 bbl. per day, almost unchanged from the preceding month when 2,709,000 bbl. were produced; and was 160,000 bbl. per day above the crude oil and natural gasoline production in March of 1934, an increase of 6.29 percent. The increased federal allowable and actual production reflected the greater demand for petroleum products due in part to seasonal influences and in part to the improving business conditions in the United States. The March, 1935, average daily crude oil production exceeded the federal allowable by 64,700 bbl. per day. During March, 1935, Texas overproduced 1,072,000 bbl.; Kansas overproduced 319,000 bbl.; and California overproduced 300,000 bbl.; while Oklahoma underproduced 10,500 bbl. The first two weeks of April indicated an overproduction above the federal quotas of about 50,000 bbl. per day.

The crude oil runs to stills during March, 1935, averaged about 2,410,000 bbl. per day, or 119,000 bbl. per day above the runs to stills during the preceding month when 2,529,000 bbl. per day were refined.

Total stocks of all petroleum products increased during February, 1935, by 2,922,000 bbl., indicating a daily gross addition to stocks of 104,300 bbl. This addition to stocks has not affected the very favorable statistical position of the oil industry, being the necessary seasonal accumulation.

Motor Fuel Demand Strong

INDICATED domestic demand for motor fuel during February, 1935, averaged 947,000 bbl. per day, an increase of 4.64 percent above the daily average during January, 1935, when 905,000 bbl. were consumed per day; the

Effect of Federal Proration Orders in Principal Oil Producing States

	Sept. 1933 to March 1935 Cumulative Overproduction		March 1935 Over-production	April 1935 Federal Daily Quota	Daily Average Production for week ending	
	bbl.	% of Total	bbl.	bbl.	April 6 bbl.	April 13 bbl.
Texas	36,183,000	54.6	1,072,000	1,021,000	1,054,500	1,048,000
Oklahoma	9,504,500	14.8	*	493,300	473,500	530,000
California	8,403,000	13.1	300,000	493,300	480,000	497,000
Kansas	2,509,000	3.9	319,000	141,000	145,000	144,000
United States	64,409,000	100.0	1,966,000	2,527,300	2,546,000	2,615,000

* Oklahoma underproduced 10,500 bbl. during March.

domestic demand during February, 1935, was 36,900 bbl. per day above the domestic motor fuel consumption in February of 1934, an increase of 4.05 percent; 105,600 bbl. per day above the domestic motor fuel consumption in February of 1933, a remarkable increase of 12.55 percent; and 44,700 bbl. per day above the domestic motor fuel consumption in February of 1931, the peak year before 1934, an increase of 4.95 percent.

The NEW YORK TIMES weekly combined business index continued to fluctuate within a narrow range during the past month, standing at 85.6 in the week ending April 13, 1935, as compared with 85.9 in the week ending March 9, 1935. The index stood at 84 on April 1, 1934; at 63 on April 1, 1933; and at 69.5 on April 1, 1932. The general business situation in the United States thus showed definite stability during the past three months, while the seasonal influences may carry the index to around 90 in the next two months. The recently appropriated federal fund of $4,800,000,000 for public works will soon begin its flow into the country and is bound to have a favorable effect, even if for a time only. Inasmuch as public works projects of any kind usually require large quantities of motor fuel, of lubricants and of other petroleum products the added federal expenditures will be reflected in larger demand. The most important factors of an anticipated very large increase in motor fuel consumption this summer are: (1) much improved highways; (2) increased speed of cars requiring more gasoline per mile; and (3) more and more general acceptance of the automobile for long trips, as a direct result of better highways.

The daily rate of exports of motor fuel averaged 42,000 bbl. in February, 1935, 39.1 percent under the preceding month; 41.8 percent under the motor fuel exports in February of 1934; 40.4 percent below the exports in February of 1933; and 67.5 percent under the motor fuel exports in February of 1931.

On March 1, 1935, motor fuel stocks at refineries, plants, terminals and in transit amounted to 63,720,000 bbl., a seasonal increase of 5,924,000 bbl. as compared with stocks on hand on February 1, 1935, indicating that during February motor fuel supply exceeded demand by 211,500 bbl. per day.

Field Developments—Texas

ON THE Gulf Coast in Chambers County, 50 miles due east from Houston and near Anahuac, the Humble Oil and Refining Company (S.O.N.J.) No. 1 Middleton in section 58, T.C.R.R. survey, after testing 6 bbl. per hour, as was reported in the preceding issue of WORLD PETROLEUM, increased its production to 32.5 bbl. per hour, making 650 bbl. of 35 gravity crude oil through 3/8-inch choke in 20 hours from a total depth of 7,088 ft. in the Frio sand. Humble Oil and Refining Company which controls all the acreage near the new discovery made two new locations for further exploration of the Anahuac field.

Also on the Gulf Coast, in Galveston County, about 20 miles southeast from Houston and in the recently discovered Dickinson field the Humble Oil and Refining Company

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GLOBE Type "K" Coring Equipment cuts cores rapidly, maintains full gauge hole and secures maximum core recovery in broken, floating and soft formations. Full floating inner barrel is assembled without threads. Globe Type "K" Coring Equipment cuts hole from 5⅝" to 20", taking cores from 2⅜" to 6⅛".

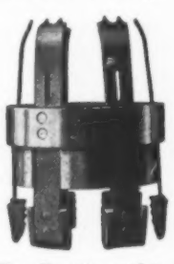
All sizes of Globe Type "KR" Roller Bearing Rock Core Heads will run on Globe Type "K" outfits. With the parts on hand to effect the change, the operator is prepared for any condition that may be presented.

The alternating short and long dogs of this core catcher are actuated by coil springs and pressure between the outer end of the dogs and a shoulder in the bit head. Effectively retains soft or broken formations.

The increased strength of the cores cut by this Globe Coring Equipment — they are 50% larger in diameter than those obtained with ordinary core barrels — and the balanced action of the perfected Globe Core Catchers assures maximum core recovery in all types of formations. The large size cores are more informative; the hazard of soft cores washing away is minimized; drilling speed is increased because there is correspondingly less formation to be removed by the bit.

Every coring problem can be solved by the use of Globe Type "K" or Type "KR" Coring Equipment. Read about it here; send for more detailed information; use this equipment yourself. It will serve you better — faster — more economically.

Each part of the Globe Type "KR" Rock Core Bit is made from steel specially selected and heat treated to develop the unusual strength and toughness necessary for repeated re-runs.



The slip type catcher is capable of pulling the hardest rock core. The slips are carried on long springs which are pointed to obtain a good grip on the core — thus forcing the slips down on the tapered seat. The dog type catcher used is the same as that used in the Type "K" outfit.

Globe Type "K" Core Heads can repeatedly be rebuilt. The teeth cut rapidly and are arranged to protect the core from the washing action of the circulation. Note the large circulation outlets which keep cutting teeth clean and remove cuttings.

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Equipped with both a slip type catcher for pulling the hardest cores and a dog type catcher which holds broken or soft formations, the Globe Type "KR" Roller Bearing Rock Core Bit provides an economical and positive means of obtaining cores in all hard formations, or where hard and soft strata alternate.

The wide variety of formations that is successfully cored with the Globe Type "KR" core barrel, and its record for almost unfailing performance have brought it into extended use in the world's oil fields.

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No. 1 Danielson, in J. Sellers Survey, extended the field ½ a mile due southeast and proved for prolific production a new horizon when it was brought in for 27 bbl. of 35.2 gravity crude oil per hour through ¼ of an inch choke from a total depth of 9,140 ft., the greatest depth of commercial production in Texas. No. 1 Danielson was first drilled to 9,360 ft. but was subsequently plugged back to 9,140 ft., after testing salt water at the total depth.

In the old Big Creek field in Fort Bend County, on the Gulf Coast, Trans State Oil Company's No. 2 Ahlers, Mich. Young survey, was completed for about 6,000 bbl. of 37 gravity crude oil per day from a Miocene sand from a total depth of 2,685 ft. The new well is surrounded by small pumpers and is apparently of negligible importance, its north offset, 85 ft. away, having been completed for 104 bbl. per day from a total depth of 2,657 ft. Moreover, the Big Creek field is characterized by sharp declines and the relatively high initial production of No. 2 Ahlers is probably accounted for by a very localized accumulation.

In Conroe field the Tide Water Oil Company increased its holdings by purchasing from the Alpha Petroleum Company 120-acre lease with seven wells known as P. G. Krohn A and B leases. The purchased leases are in the main Conroe sand and increase the company's reserves in the field by 3,420,000 bbl.

Recent completions in the East Texas field, now averaging between 90 and 100 per week, increased the total number of producing wells in the field to 17,100 by May 1, 1935, bringing the well spacing down to 6.8 acres per well. The bottom-hole pressure declined to 1,217, lbs. in April, as compared with 1,220 lbs. in November, 1934, a new low.

Gulf Production Company's No. 103 J. T. McElroy in Crane County, the deepest well ever drilled in the world, is now drilling at 12,414 ft., about 1,000 ft. in the Ordovician section, without any oil, gas or water showings.

Oklahoma

THE Fitts pool by the middle of April had 80 producing oil wells with a total daily potential of about 275,000 bbl. Current daily production averages 14,200 bbl. Recent important completion was the E. W. Moore et al No. 1 Mitchell in section 31-T2N-R7E which extended the field ¼ of a mile due south when it was completed for about 7,000 bbl. per day initially from 4,415 ft. in the McLish zone of Simpson series, thus opening for production a second producing sub-horizon in the Fitts pool. Phillips Petroleum Company defined the Fitts field to the west when its No. 4 T. Norris in section 25-T2N-R6E tested salt water with a total depth of 4,418 ft.

In the Edmond field of Oklahoma County 3 new large wells were completed during the past month bringing the number of producers to eight. Marathon Oil Company (S. O. Ohio) completed its No. 3 Dahl in section 31-T14N-R3W for 7,400 bbl. initially from the Simpson "Wilcox" sand topped at 6,620 ft.; Mid-Continent Petroleum Corporation brought in its No. 2 Young in section 31-T14-R3W for about 20,000 bbl. per day initially

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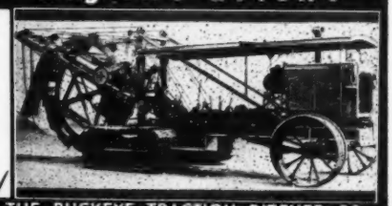

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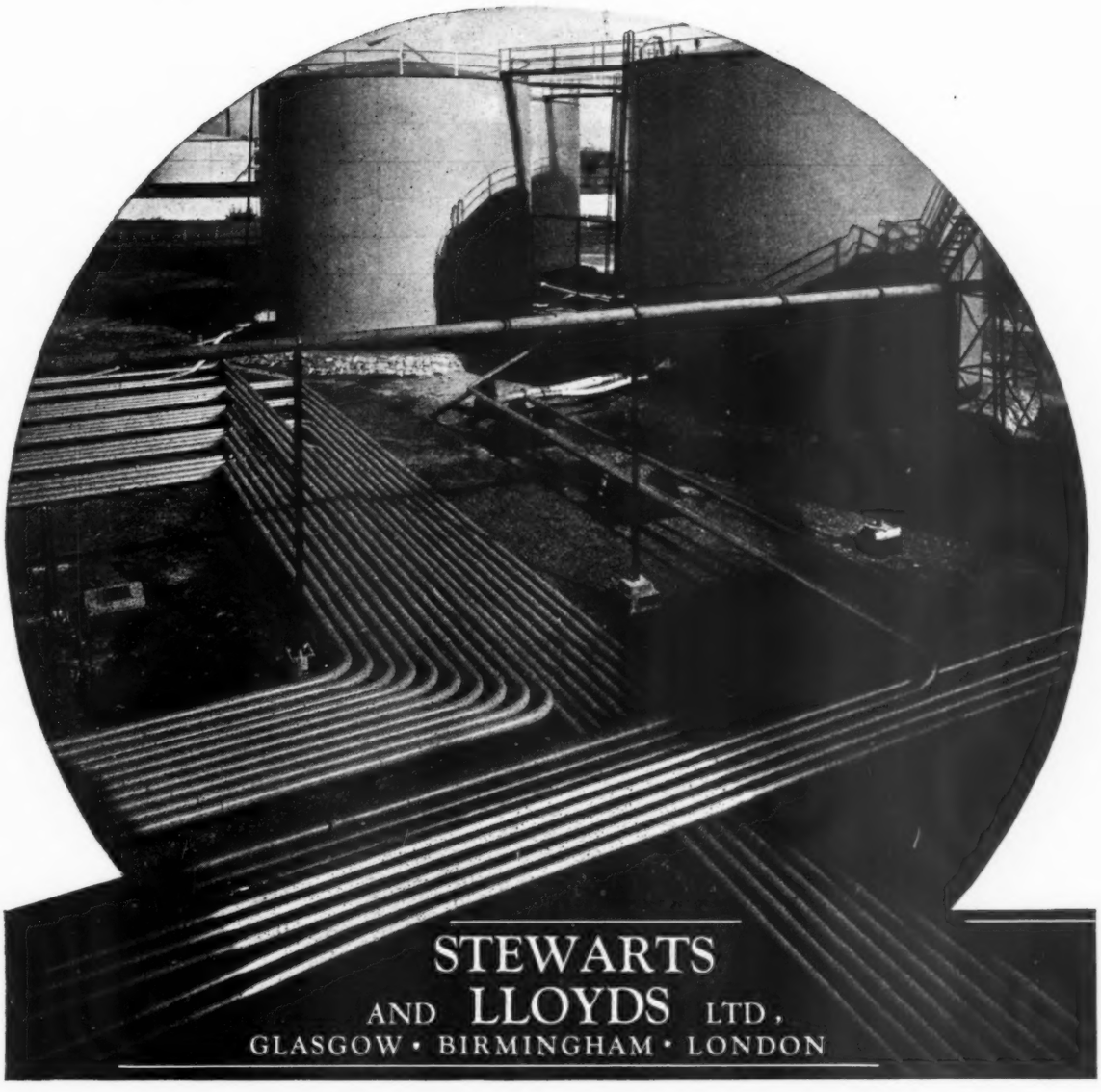

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with a total depth of 6,694 ft.; and Continental Oil Company completed its No. 1 Young in the same section for about 9,000 bbl. initially from 6,705 ft. The Edmond pool is thus developing, as was anticipated, into a highly prolific but areally small field.

The deepest producing well in the world, the Denver Producing and Refining Company's No. 1 A-dah-noe in section 34-TION-RIOW, near Binger, is gradually increasing its output, producing now about 80 bbl. per day on gas lift from a lower Pennsylvanian sand encountered at 9,600 ft.

New Mexico

AMERADA Petroleum Corporation's No. 1-D State in section 1-T20S-R36E in Lea County, near Monument, six miles due south from Hobbs field and 10 miles due north from Eunice field, which drilled to 3,954 ft. for a 600 bbl. producer showing salt water, was plugged back to 3,946 ft. and treated with 2,000 gallons of acid, responding with a 3,600 bbl. production per day through 3-inch tubing, thus opening a new apparently important oil field in southeastern New Mexico.

Michigan

THE RECENT discovery by J. W. Leonard Drilling Company in Crystal township, No. 1 O. Durbin in section 11-TION-R5W, continued to produce around 3,000 bbl. per day under about 400 lbs. of back pressure from the Dundee limestone topped at 3,187 ft. and penetrated 11 ft. The new discovery proves for major production a second trend paralleling the Greendale-Porter which is located about 30 miles due northeast from the Crystal discovery. Some 20 new projects have been started near the new well, of these 10 are near the discovery, while the balance is of exploratory nature several miles away. Pure Oil Company built a short pipeline to the new well and the Simrall-Roosevelt interests have one under consideration.

BASIL B. ZAVOICO

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Corrections

THE FEBRUARY issue of WORLD PETROLEUM contained a report from Haifa, Palestine, that Consolidated Petroleum Company through the Shell Company of Palestine would erect a refinery at Haifa to serve the local market in that territory. We are now advised that this report was incorrect.

IN THE March issue an illustration was given of a Crossley Diesel generator set and a Crossley Diesel pumping set. It was stated that these two engines were for the Anglo-Persian Oil Co.'s Kermanshah pipeline. However, this is not quite correct. The engine in the foreground is one of nine Crossley engines connected to turbine pumps and recently supplied to the Burmah Oil Company, Ltd. The engine in the background is a Crossley Diesel generator set and is one of three supplied for the Anglo-Persian Oil Co.'s Kermanshah operations.

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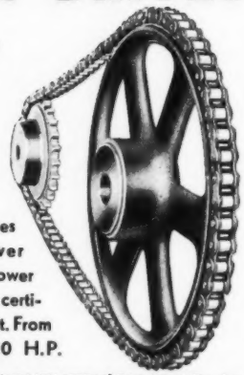

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MEXICO

THREE court rulings are of great interest to the Mexican petroleum industry. Federal supreme court held that lands which are incorporated in the national oil reserves cannot be considered as free when they harm the interests of a third party in upholding an injunction granted Epitacio and Enrique Resendez by a Monterrey, Nuevo Leon state, district court against action of ministry of national economy in cancelling confirmatory concessions to lands they own in Nuevo Leon and ordering the tracts added to the reserves.

High court sustained an injunction granted Huasteca Petroleum Co. by a San Luis Potosi City district tribunal against ruling of the federal arbitration and conciliation board that oil company must pay employees of its Mata Redonda, Vera Cruz state, unit some 300,000 pesos (approximately $85,000, U. S.) as wages for the time they have been on strike.

First district court, Mexico City, issued owners of more than 2,000 hectares (a hectare is 2.47104 acres) on the San Pedro de Miradores and Santa Cecilia ranches, Oaxquihui municipality, Vera Cruz state, an injunction restraining the federal and state governments, federal agrarian department and ministry of national economy from parceling out these lands to agrarians. Court upheld land owners' contention that defendants' action violates national constitution which specifies that oil lands cannot be distributed under the agrarian laws. Mexican Eagle Oil Co. (Royal Dutch Shell) is paying rents on lands involved in this suit and royalties on oil extracted from them.

BRINGING in of two more Vera Cruz state oil wells, Poza Rica No. 9 in the Poza Rica fields and El Plan No. 45 in the El Plan zone, is announced by ministry of national economy. Former well came in at 7,827 ft. and began production 2,516 bbl. daily. Latter had initial daily output of 1,258 bbl. at 1,867 ft. El Plan well is owned by Mexican Eagle Oil Co. which is doing much development work in El Plan zone.

Deposits totaling 35,000,000 pesos (approximately $9,720,000, U. S.) have been accepted by federal supreme court from Mexican Eagle Oil Co. to secure, as stipulated by Mexican law, its appeal from a partial decision by that tribunal of suit for some 36,000,000 pesos brought against Eagle by Compañia Petrolera Comercial, S. A. which seeks that sum as compensation for alleged extraction by the defendant of about 9,000,000 bbl. of oil from Lot 113, Amatlan zone, Vera Cruz state. Deposit was made in accord with high court's demand after it had refused to accept a substantial security Eagle posted in a London, England, bank, and ordered that company must post cash bonds in this case with Mexican banks in Mexico. Of the 35,000,000 peso deposit, 19,000,000 pesos were placed in the Mexico City headquarters of Bank of Mexico, this country's central bank, and 16,000,000 pesos, secured by three refineries, some other immovable properties and a considerable quantity of petroleum, worth in all about 60,000,000 pesos, put in the Mexico City offices of National Bank of Mexico, the largest private Mexican bank. Court is now proceeding with the case.

Mexican Eagle officials deny Mexico City newspaper stories to the effect that Comercial has embargoed its refinery and other properties at Minatitlan, Vera Cruz. They explain that neither the Eagle nor the Comercial can act in any way in this suit until national supreme court has finally decided the action.

DOUGLAS GRAHAM

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Washington News

A SELECTIVE but representative compilation of references to the more important articles on oil appearing in American trade and general magazines from the Spring of 1933 to January 1, 1935, with an addenda consisting of a complete list of Petroleum Administration press releases, classified by subject matter, date of issue and official number, has been prepared for general distribution by the Oil News Bureau, 808 Investment Building, 15th and K streets, Northwest, Washington, D. C. Mimeographed and bound, contains 26 pages and about 800 items, for a price of 50 cents the individual copy; 25 cents each if 12 or more are purchased. Quarterly supplements will be issued, the first on April 1, 1935, at 15 cents each or 10 cents each in quantity purchases. Price is postage prepaid.

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New Equipment

THE Jerguson Gage and Valve Company announces three new designs to keep abreast of recent developments in the oil industry. The first has a tabular gage glass protected by four shatter-proof glass panels. The second is a close hook-up reflex or transparent type gage which gives clear vision over practically the entire cock center distance. The third is of the vacuum gage glass type which eliminates frosting of the column at sub-zero temperatures.

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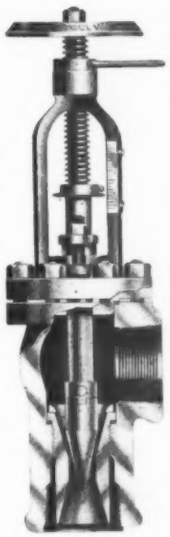

The Shaffer Flow Beans on a well recently completed in the Belridge field in California held and operated under a back pressure of 3,400 pounds per square inch. These Beans were used both to control flow and for complete shut-off. This is probably the highest well pressure on record and is convincing proof of the dependability of Shaffer Products to meet the severest conditions.

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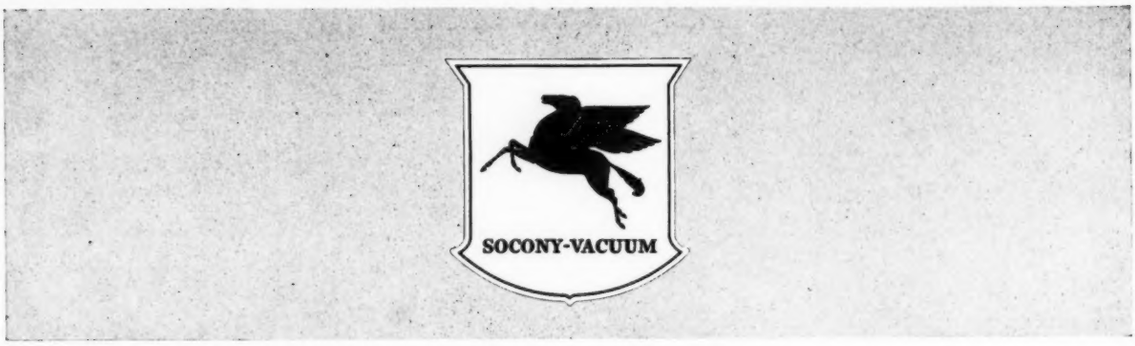

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